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# Impact of an Omnidirectional Traffic Alert and Collision Avoidance System on the Air Traffic Control Radar Beacon System and the Discrete Address Beacon System

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16. Abstract

A computer analysis was conducted to investigate the effect of an omnidirectional version of the Traffic Alert and Collision Avoidance System (TCAS) on the performance of: 1) the Air Traffic Control Radar Beacon System (ATCRBS), and 2) the planned Discrete Address Beacon System (DABS) in selected air traffic environments. The performance of ATCRBS and DABS was examined both with and without the TCAS in operation. Additional simulations were conducted to quantify the effect of TCAS when employing its interference-limiting function.

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# PREFACE

The Electromagnetic Compatibility Analysis Center (ECAC) is a Department of Defense facility, established to provide advice and assistance on electromagnetic compatibility matters to the Secretary of Defense, the Joint Chiefs of Staff, the military departments and other DoD components. The center, located at North Severn, Annapolis, Maryland 21402, is under policy control of the Assistant Secretary of Defense for Communication, Command, Control, and Intelligence and the Chairman, Joint Chiefs of Staff, or their designees, who jointly provide policy guidance, assign projects, and establish priorities. ECAC functions under the executive direction of the Secretary of the Air Force and the management and technical direction of the Center are provided by military and civil service personnel. The technical support function is provided through an Air Force sponsored contract with the ITT Research Institute (IITRI).

This report was prepared for the Systems Research and Development Service of the Federal Aviation Administration in accordance with Interagency Agreement DOT-FA70WA1-175, as part of AF Project 649E under Contract F-19628-80-C-0042, by the staff of the IIT Research Institute at the Department of Defense Electromagnetic Compatibility Analysis Center.

To the extent possible, all abbreviations and symbols used in this report are taken from American Standards Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the USA Standards Institute.

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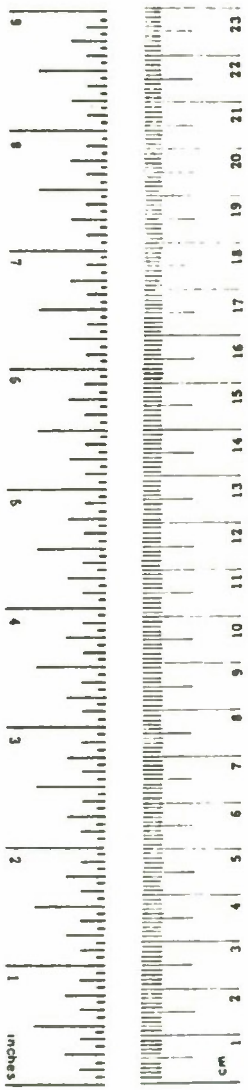
# METRIC CONVERSION FACTORS

## Approximate Conversions to Metric Measures

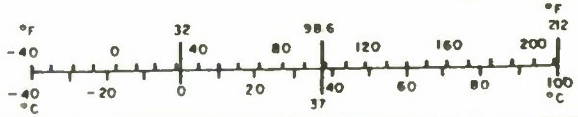
| Symbol | When You Know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| in | inches | *2.5 | centimeters | cm |
| ft | feet | 30 | centimeters | cm |
| yd | yards | 0.9 | meters | m |
| mi | miles | 1.6 | kilometers | km |
| | | **AREA** | | |
| $in^2$ | square inches | 6.5 | square centimeters | $cm^2$ |
| $ft^2$ | square feet | 0.09 | square meters | $m^2$ |
| $yd^2$ | square yards | 0.8 | square meters | $m^2$ |
| $mi^2$ | square miles | 2.6 | square kilometers | $km^2$ |
| | acres | 0.4 | hectares | ha |
| | | **MASS (weight)** | | |
| oz | ounces | 28 | grams | g |
| lb | pounds | 0.45 | kilograms | kg |
| | short tons (2000 lb) | 0.9 | tonnes | t |
| | | **VOLUME** | | |
| tsp | teaspoons | 5 | milliliters | ml |
| Tbsp | tablespoons | 15 | milliliters | ml |
| fl oz | fluid ounces | 30 | milliliters | ml |
| c | cups | 0.24 | liters | l |
| pt | pints | 0.47 | liters | l |
| qt | quarts | 0.95 | liters | l |
| gal | gallons | 3.8 | liters | l |
| $ft^3$ | cubic feet | 0.03 | cubic meters | $m^3$ |
| $yd^3$ | cubic yards | 0.76 | cubic meters | $m^3$ |
| | | **TEMPERATURE (exact)** | | |
| °F | Fahrenheit temperature | 5/9 (after subtracting 32) | Celsius temperature | °C |

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.




## Approximate Conversions from Metric Measures

| Symbol | When You Know | Multiply by | To Find | Symbol |
|---|---|---|---|---|
| | | **LENGTH** | | |
| mm | millimeters | 0.04 | inches | in |
| cm | centimeters | 0.4 | inches | in |
| m | meters | 3.3 | feet | ft |
| m | meters | 1.1 | yards | yd |
| km | kilometers | 0.6 | miles | mi |
| | | **AREA** | | |
| $cm^2$ | square centimeters | 0.16 | square inches | $in^2$ |
| $m^2$ | square meters | 1.2 | square yards | $yd^2$ |
| $km^2$ | square kilometers | 0.4 | square miles | $mi^2$ |
| ha | hectares (10,000 $m^2$) | 2.5 | acres | |
| | | **MASS (weight)** | | |
| g | grams | 0.035 | ounces | oz |
| kg | kilograms | 2.2 | pounds | lb |
| t | tonnes (1000 kg) | 1.1 | short tons | |
| | | **VOLUME** | | |
| ml | milliliters | 0.03 | fluid ounces | fl oz |
| l | liters | 2.1 | pints | pt |
| l | liters | 1.06 | quarts | qt |
| l | liters | 0.26 | gallons | gal |
| $m^3$ | cubic meters | 35 | cubic feet | $ft^3$ |
| $m^3$ | cubic meters | 1.3 | cubic yards | $yd^3$ |
| | | **TEMPERATURE (exact)** | | |
| °C | Celsius temperature | 9/5 (then add 32) | Fahrenheit temperature | °F |



# EXECUTIVE SUMMARY

An omnidirectional version of the Traffic Alert and Collision Avoidance System (TCAS), referred to in the past as the active Beacon Collision Avoidance System (BCAS), analyzed in this report provides the collision-avoidance function for TCAS-equipped aircraft against aircraft equipped with either Air Traffic Control Radar Beacon System (ATCRBS) or Discrete Address Beacon System (DABS) transponders. The Federal Aviation Administration (FAA) requested that the Electromagnetic Compatibility Analysis Center (ECAC) investigate the effect of TCAS on ATCRBS and DABS performance.

A computer simulation model of the proposed TCAS was developed to predict the impact of TCAS emissions on ground-based Air Traffic Control (ATC) systems. The model simulates TCAS-generated interrogations and merges them with interrogations generated by the ground ATC system in the ECAC-maintained DABS/ATCRBS/AIMS Performance Prediction Model (PPM).

Simulations were conducted to determine the impact of TCAS emissions on the performance of a) the Long Beach ATCRBS interrogator, and b) a hypothetical DABS sensor at Los Angeles (LAX-4), in hypothesized air traffic deployments for the Los Angeles Basin. Seven deployments were constructed as subsets of a hypothesized Los Angeles Basin deployment. Predictions were also made of the uplink suppression and interrogation rates.

Ground system performance was predicted both with and without TCAS operation, and with and without TCAS employing an interference-limiting procedure. ATCRBS performance is based on the ability of the processor to detect aircraft and to validate Mode A (identity) and Mode C (altitude) reply codes. DABS performance is based on the ability of the DABS sensor to elicit decodable surveillance and data-link replies from DABS-equipped aircraft with a minimum number of interrogations, and to detect ATCRBS aircraft and receive Modes A and C reply codes with high confidence.

For the ATCRBS interrogator at Long Beach, it was predicted that deploying TCAS, with or without interference-limiting, in any of the various air traffic deployments:

1. Will not reduce target detection probabilities.
2. Will reduce the Mode A validation probability by less than 2%.
3. Will reduce the Mode C validation probability by less than 2%.

Deploying TCAS, with interference-limiting, in any of the various air traffic deployments will reduce average transponder reply probability by less than 2%.

For the hypothetical DABS sensor at Los Angeles, it was predicted that deploying TCAS, with or without interference-limiting, in any of the various air traffic deployments:

1. Will not reduce the target detection probability.
2. Will not reduce the high-confidence Mode A validation probability.
3. Will reduce the high-confidence Mode C validation probability by less than 1%.
4. Will increase the roll-call interrogation rate by less than 6%.

Deploying TCAS, with interference-limiting, in any of the various air traffic deployments, will not reduce the high-confidence Mode C validation probability and will reduce the average transponder reply probability by less than 2%.

For the peak air traffic deployment simulation (743 aircraft within 60 nmi of Los Angeles) with approximatly 25% of the aircraft equipped with TCAS, it was predicted that 133 of the 188 TCAS units were required to limit CAS transmissions; 2 of these units were required to terminate CAS activity.

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# SECTION 1

# INTRODUCTION

## BACKGROUND

Several airborne Collision Avoidance Systems (CAS) that are compatible with the existing FAA Air Traffic Control Radar Beacon System (ATCRBS) and the future Discrete Address Beacon System (DABS) have been proposed. Both active and passive CAS systems are under development. Passive systems monitor replies elicited by ground-based interrogations. Active systems transmit interrogations from airborne interrogators to elicit replies from cooperating transponders.

The proposed omnidirectional active Beacon Collision Avoidance System (BCAS),[1,2,3,4,5], henceforth referred to as the Traffic Alert and Collision Avoidance System (TCAS), analyzed in this study employs two signal formats, one that is compatible with the existing ATCRBS (Mode C) format and one that is compatible with the proposed DABS signal format (Mode S). TCAS is intended to provide the CAS function in a mixed environment of DABS and ATCRBS transponder-equipped aircraft; it is capable of interrogating both Mode C- and Mode S-equipped aircraft.

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[1]Preliminary Draft, Active BCAS Engineering Requirement, FAA, Washington, DC, 1 June 1976.

[2]Mann, Patricia, Simulation of Surveillance Processing Algorithms Proposed For The DABS Mode of BCAS, FAA-RD-77-138, FAA, Washington, DC, February 1978.

[3]"U.S. National Standard Active Beacon Collision Avoidance System (BCAS)," Federal Register, Vol 43, N0246, October 20, 1980.

[4]Beacon Collision Avoidance System (BCAS) Quarterly Technical Letter, BCAS QTL-4-11, Lincoln Laboratory, Lexington, MA, 24 July 1979.

[5]Beacon Collision Avoidance System (BCAS) Quarterly Technical Letter, BCAS QTL-4-12, Lincoln Laboratory, Lexington, MA, 22 October 1979.

During FY-77, the FAA requested that the Electromagnetic Compatibility Analysis Center (ECAC) investigate the impact of BCAS operation on ATCRBS performance in a hypothetical Washington, DC, area 1981 deployment (based on the 1975 deployment, increased by 3% per year).[6] In that traffic deployment, it was predicted that deploying the BCAS would result in a slight reduction in transponder reply probability but not sufficient to result in an effect on the ATCRBS ground receiver/processor performance. A similar analysis was conducted by ECAC in FY-78 to investigate the impact of BCAS on ATCRBS and DABS performance in the Los Angeles Basin. This analysis was suspended to allow time for BCAS modifications to be incorporated into the ECAC model.[7]

Following these studies, the design for BCAS was modified to include interference-limiting features, and an Automatic Traffic Advisory and Resolution Service (ATARS) information data link. In addition, the Radar Beacon Transponder (RBX) units replaced the Desensitization Control Units (DCU) of the previous studies.

In view of these and other system changes, and to further investigate the impact of the TCAS on ATCRBS and DABS performance, ECAC was tasked to perform an analysis (similar to the FY-77 Washington, DC, and the FY-78 Los Angeles studies) in seven air traffic deployments for the Los Angeles Basin. These seven deployments as constructed are subsets of a hypothesized peak Los Angeles Basin deployments.[8]

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[6] Theberge, Norman, The Impact of a Proposed Active BCAS on ATCRBS Performance in the Washington, DC, 1981 Environment, FAA-RD-77-140, FAA, Washington, DC, September 1977.

[7] Crawford, C. R., and Ehler, C. W., The DABS/ATCRBS/AIMS Performance Prediction Model, FAA-RD-79-088, Annapolis, MD, November 1979.

[8] Hildenberger, Mark, User's Manual for the Los Angeles Basin Standard Traffic Model Card Deck/Character Tape Version), FAA-RD-73-89, FAA, Washington, DC, May 1973.

## OBJECTIVE

The objective of the analysis was to determine the impact of the TCAS on the performance of ATCRBS and DABS air traffic control systems in a hypothesized Los Angeles Basin air traffic deployment and in subsets of that deployment.

## APPROACH

Using the time-event-store DABS/ATCRBS/AIMS Performance Prediction Model (Reference 7) supplemented with a statistical submodel of the TCAS, an analysis was conducted to determine the impact of TCAS operation on the performance of the ATCRBS and DABS ground systems.[a] For each air traffic deployment of the Los Angeles Basin, the performance of ATCRBS and DABS was predicted both with and without TCAS operation (and with and without TCAS interference-limiting).

Two ground deployments were modeled, both of which were obtained from ATCRBS/IFF files at ECAC. The first, as specified by the FAA, consisted of all interrogators within a 500-nmi radius of Los Angeles. The second differed from the first in that four specified FAA ATCRBS interrogators were converted to DABS sensors.

Performance of all transponders within range of the interrogator-of-interest ($I_o$) was assessed in terms of the suppression rate, interrogation rate, and reply probability. The impact of TCAS on the ATCRBS ground system at Long Beach was evaluated in terms of variations in ATCRBS fruit rate, DABS fruit rate, and ARTS III[b] target detection and code validation probabilities associated with TCAS activity. The impact of TCAS on the DABS ground system at Los Angeles was also evaluated in terms of variations in ATCRBS fruit rate,

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[a]The model description relevant to this analysis is contained in APPENIDIX D.

[b]ARTS III - reply processor associated with ATCRBS FAA terminal sites, correlates replies to determine aircraft range, altitude, and identification.

DABS fruit rate, DABS roll-call transactions, and ATCRBS target detection and code confidence probabilities associated with TCAS activity.

It should be emphasized that although system parameters such as interrogation rates, suppression rates, and reply probabilities are useful and meaningful transponder performance indicators, the parameters of primary significance are those defining the ability of the ground system to perform its fundamental air traffic control function of reliably detecting aircraft.

# SECTION 2

# MODEL INPUTS

## INTERROGATOR-OF-INTEREST OPERATION

To determine the effect of TCAS on ATCRBS and DABS, the ground system performance with and without TCAS was simulated for both the Long Beach ATCRBS interrogator and the hypothetical Los Angeles (LAX-4) DABS sensor. The simulations with TCAS deployed were performed both with and without TCAS employing interference-limiting procedures. The characteristics and locations of the ATCRBS interrogator at Long Beach and the DABS sensor at Los Angeles, along with the transponder characteristics, as modeled, are given in TABLES 1 and 2, respectively.

The Long Beach ATCRBS interrogator was assumed to utilize an ARTS III processor; its performance was based on the ability of the processor to detect and to validate Mode A (identity) and Mode C (altitude) reply codes. Detection required receiving 5 clear replies from the 21 interrogations that each aircraft received during the mainbeam dwell period. Validation required receiving 2 consecutive clear replies to interrogations of the same mode. Fruit replies (false replies uncorrelated in time) that overlapped elicited replies were assumed to garble the desired replies to the extent that they could not be properly decoded regardless of the relative power levels.

The hypothesized LAX-4 DABS sensor has the processing capability to decode both ATCRBS and DABS replies. The performance of the ATCRBS mode of DABS is based on the ability of its processor to detect aircraft and to declare high- confidence Mode A and Mode C reply codes. Detection required two clear framing pulse pairs in response to interrogations of either mode. Declaration of high-confidence mode requires receipt of a single composite clear reply constructed from the set of replies to that particular mode. DABS surveillance and data-link performance is based on the ability to elicit decodable (Reference 8) roll-call replies from aircraft located within its surveillance and data-link volumes with a minimum number of interrogations. The surveillance and data-link interrogation rates are variables depending upon aircraft location and type. These rates are discussed on page 12.

TABLE 1

PARAMETER ASSIGNMENTS IN THE LONG BEACH SCENARIO

Long Beach ATCRBS Interrogator Characteristics

| | |
|---|---|
| Latitude | 33°49'09"N |
| Longitude | 118°08'16"W |
| Power | 0.08 kW (at antenna) |
| Scan Rate | 13 rpm |
| Interrogation Rate | 415/s |
| Mode Interlace | A, A, C |
| Receiver Sensitivity (MTL) | -86 dBm |
| Receiver Range | 60 nmi |
| Interrogator Type | ATCBI-0003D |
| Cabling Loss | 4 dB |
| STC (Sensitivity Time Control) | 40 dB @ 1 nmi |
| Antenna Gain and Beamwidth | 21 dBi for 4° |
| SLS Type | Improved sidelobe suppression (ISLS) |

Transponder Characteristics

| | |
|---|---|
| Power | 0.5 kW (at transmitter) |
| Receiver Sensitivity (MTL)[a] | |
| ATCRBS Transponders | -74 dBm |
| DABS Transponders | -77 dBm |
| Cable Loss | 3 dB |
| Antenna Gain (omnidirectional) | -2.5 dBi |

[a]Added in proof. The current version of the National Standard (Reference 3) for Mode S (DABS) transponders established a -74 dBm nominal MTL.

TABLE 2

PARAMETER ASSIGNMENTS IN THE LAX SCENARIO

| | |
|---|---|
| <u>LAX DABS Sensor Characteristics</u> | |
| Latitude | 33°57'12"N |
| Longitude | 118°24'00"W |
| Power | 0.1 kW (at antenna) |
| Scan Rate | 13 rpm |
| PRF Interrogation Rate | 128/s[a] |
| Mode Interlace | A, C |
| Receiver Sensitivity (MTL) | -88 dBm |
| Range of Receiver | 200 nmi |
| Cabling Loss | 4 dB |
| Antenna Gain and Beamwidth | 21 dBi for 4° |
| SLS Type | Receiver SLS |
| STC (Sensitivity Time Control) | N/A |
| <u>Transponder Characteristics</u> | |
| Power | 0.5 kW (at transmitter) |
| Receiver Sensitivity (MTL)[b] | |
| ATCRBS Transponders | -74 dBm |
| DABS Transponders | -77 dBm |
| Cable Loss | 3 dB |
| Antenna Gain (omnidirectional) | -2.5 dBi |

[a]The reciprocal of the time interval between DABS all-call interrogations.

[b]Added in proof. The current version of the National Standard (Reference 3) for Mode S (DABS) transponders established a -74 dBm nominal MTL.

## DEAD TIMES

Because TCAS transmits ATCRBS interrogations and suppressions and DABS interrogations, the total dead time of transponders within its range is increased, thereby reducing their reply efficiency. The dead times that were assumed for this analysis are shown in TABLE 3:[9,10]

TABLE 3

TRANSPONDER DEAD TIMES

| Type Transmission | Transponder Type | Transponder Dead Time (μs) |
|---|---|---|
| ATCRBS Interrogation | ATCRBS | 60 |
| ATCRBS-Only Interrogation[a] | ATCRBS | 60 |
| ATCRBS Suppression | ATCRBS | 35 |
| DABS Interrogation (All-Call and Roll-Call) | ATCRBS | 35 |
| ATCRBS Interrogation | DABS | 60 |
| ATCRBS-Only Interrogation[b] | DABS | 35 |
| ATCRBS Suppression[b] | DABS | 35 |
| DABS Interrogation (at transponder address) | DABS | 192 (short reply)<br>248 (long reply) |
| DABS Interrogation[b] (not at transponder address) | DABS | 35 |
| DABS All-Call Interrogation | DABS | 128 |
| RBX Interrogation | DABS | 128 |

[a]ATCRBS-only interrogations are transmitted by DABS sensors and TCAS interrogators.

[b]This desensitization effect was modeled as a suppression.

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[9]Notice in the Federal Register, Vol. 43, No. 59, Monday, March 27, 1978, Part II, entitled, "Proposed U.S. National Aviation Standard for the Discrete Address Beacon System (DABS)."

[10]"U.S. National Standard for IFF Mark X (SIF)/Air Traffic Control Radar Beacon System Characteristics," Agency Order 1010.51, FAA, Washington, DC, March 1971.

# EQUIPMENT DEPLOYMENT

## Aircraft Deployments

Seven aircraft deployments were used in this analysis. All were constructed by selecting aircraft from a hypothesized peak Los Angeles Basin air traffic deployment (see Reference 8) supplied to ECAC by the FAA. This deployment consisted of 743 aircraft within 60 nmi of LAX (689 general aviation, 30 air carrier and 24 military aircraft).

Four of the air traffic deployments were constructed by decreasing the aircraft population while maintaining a nominal mix of 25% DABS (11% TCAS),[a] and 75% ATCRBS transponder-equipped aircraft. The full-scale deployment (deployment A) included the maximum air traffic density (0.159 A/C per square nmi within 30 nmi of LAX) with the 30 air-carrier, the 53 high-performance general-aviation and 105 of the remaining general-aviation aircraft modeled as equipped with DABS transponders. The air-carrier and the high-performance general-aviation aircraft were also modeled to be equipped with TCAS interrogators. The remainder of the air traffic population was modeled as equipped with ATCRBS transponders. Three reduced deployments (deployments B, C, and D) were constructed by randomly deleting aircraft from the full-scale environment to produce aircraft densities of approximately 0.08, 0.04, and 0.02 A/C per square nmi.

Three additional deployments (E, F, and G) were developed from deployments A and B by varying the percentage of transponders that are ATCRBS-, DABS-, and TCAS-equipped. Deployment E is similar to deployment A; however, all DABS transponders are TCAS-equipped; deployment F was constructed from deployment B in the same manner. Deployment G consisted of 0.08 aircraft per square nmi with 46% of the transponder population ATCRBS-equipped and 54% DABS-equipped (44% of DABS-equipped are TCAS equipped). These deployments are

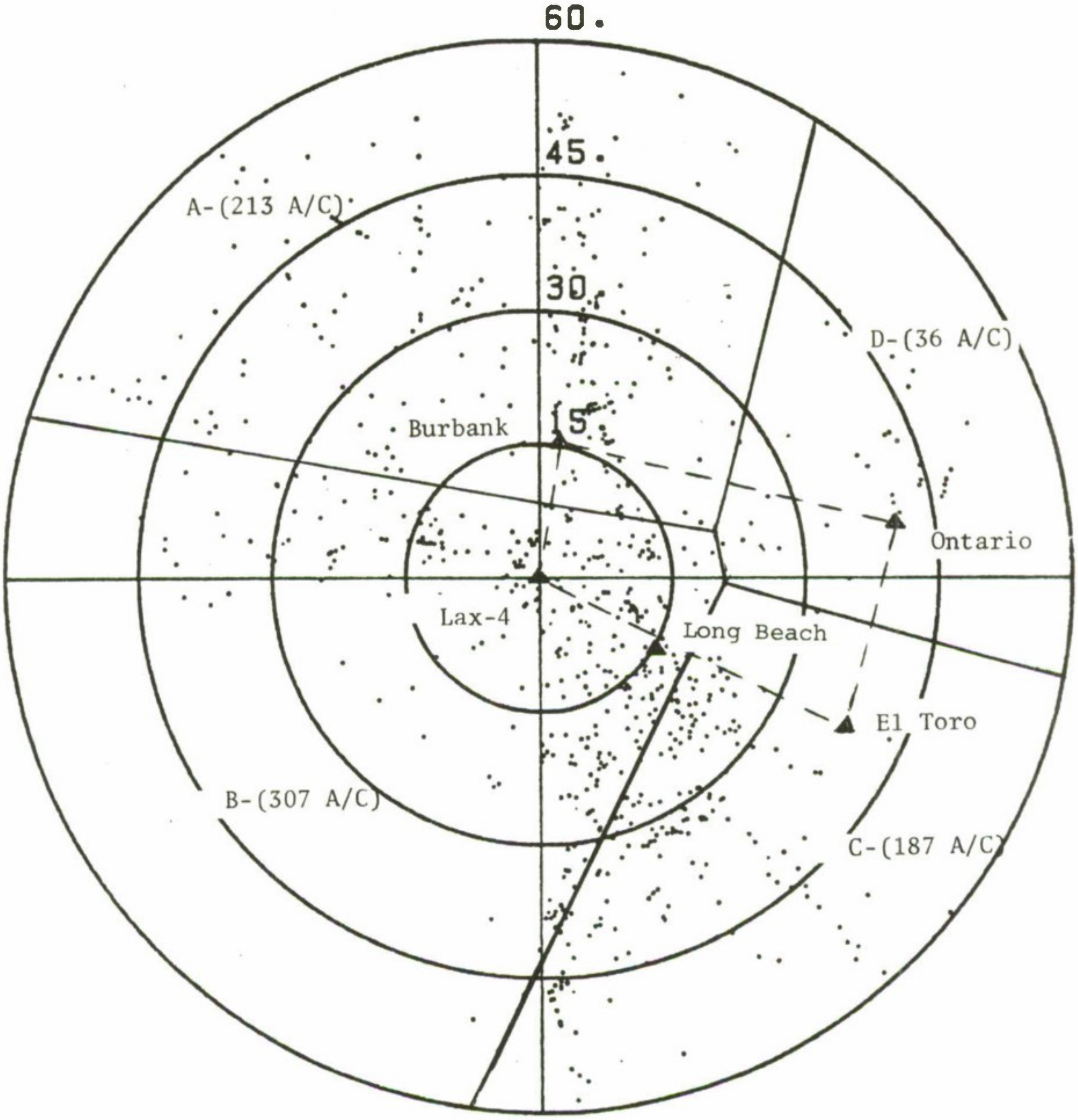
[a]This notation will be used throughout the report. 25% DABS (11% TCAS) means that 25% of the aircraft are DABS-equipped and 11% of the aircraft are TCAS-equipped. All TCAS-equipped aircraft are also DABS-equipped.

summarized in TABLE 4. Range and altitude distributions are given in TABLES A-1 through A-8 of APPENDIX A. Figure 1 shows the full-scale deployment as seen by the Los Angeles interrogator and displays the DABS sensor surveillance zones, which are discussed later. Figures A-1 through A-7 show each of these aircraft deployments along with the corresponding DABS-equipped and TCAS-equipped aircraft locations.

TABLE 4

AIRCRAFT DEPLOYMENTS USED IN THE ANALYSIS

| | Deployment | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G |
| Total Number of Aircraft (within 60 nmi of LAX) | 743 | 386 | 201 | 92 | 743 | 386 | 386 |
| Approximate Density (within 30 nmi of LAX) | 0.159 | 0.08 | 0.04 | 0.02 | 0.159 | 0.08 | 0.08 |
| Number DABS-Equipped (TCAS-Equipped) | 188 (83) | 87 (40) | 48 (23) | 20 (12) | 188 (188) | 87 (87) | 203 (87) |
| Number ATCRBS-Equipped | 555 | 299 | 153 | 72 | 555 | 299 | 183 |
| Maximum Aircraft Density Within 10 nmi of Any TCAS-Equipped Aircraft | 0.398 | 0.201 | 0.099 | 0.038 | 0.436 | 0.220 | 0.220 |




A,B,C, and D are the primary surveillance zones of the DABS sensors at Burbank, Los Angeles, El Toro, and Ontario, respectively.

Figure 1. Transponder deployment (Origin is LAX-4, 33°57'12"N, 118°24'00"W).

## Ground Interrogator Deployments

Two ground deployments, as specified by the FAA, were modeled by selecting interrogators from ECAC's ATCRBS/IFF files. The first deployment consisted of the 141 ATCRBS interrogators within 500 nmi of LAX. This deployment is illustrated in Figure 2, and was used to predict the impact of TCAS operations on the Long Beach ATCRBS ground sensor. The second deployment differed from the first in that four FAA terminal interrogators were converted to DABS sensors. This deployment was used to predict the impact of TCAS on DABS at LAX. The four converted interrogators were Los Angeles (LAX-4), Burbank, El Toro, and Ontario. Their surveillance and data-link coverage zones are given in TABLE 5 and illustrated in Figure 1. DABS channel activity is discussed below.

The DABS signal environment consisted of a combination of surveillance, and CDTI (Cockpit Display of Traffic Information) services.[9,11] The service level provided to each aircraft from each DABS sensor was dependent upon aircraft type. Air-carrier and high-performance general-aviation aircraft (11% of the aircraft population) received from their primary sensor high-option CDTI or Extended Length Message (ELM) service that consisted of a series of Comm-C data segments addressed to a particular aircraft, containing information about other aircraft (targets) in the immediate vicinity (within the threat volume) of the addressed aircraft. The threat volume was arbitrarily chosen to extend for 3 nmi radially and within an altitude of ±2500 ft. This entailed transmitting ((T/2)+2.5) ru Comm-C segments per scan, where T was the number of targets within the threat volume (ru denotes "rounding upward" to the next larger integer). All but two of the Comm-C

[11] Keech, T., and Fleming, G., Impact of the Discrete Address Beacon System (DABS) on Air Traffic Control Radar Beacon System (ATCRBS) Performance in Selected Deployments, FAA/RD-80-93, Annapolis, MD, November 1979.

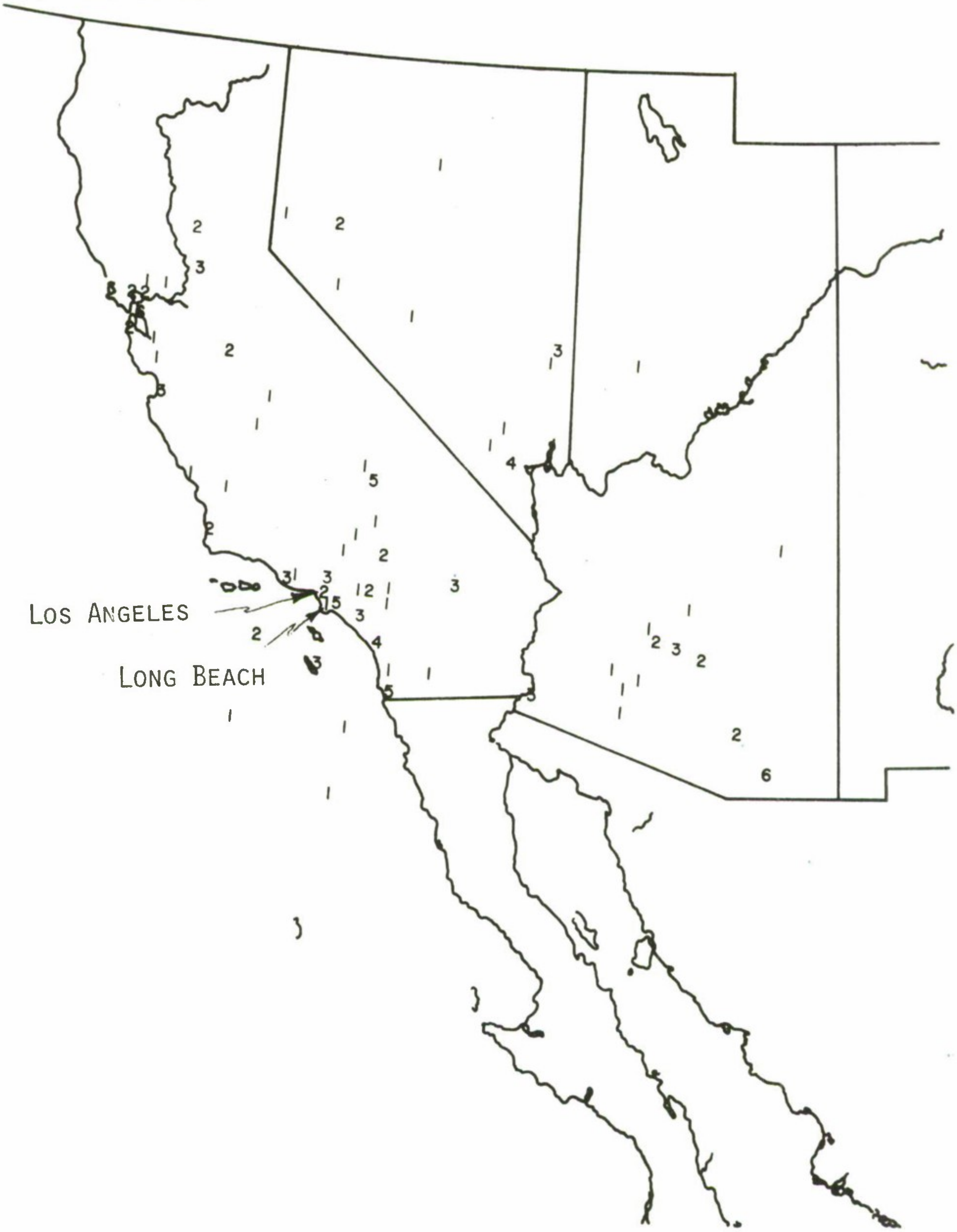



Figure 2. Ground interrogator environment (Numerals indicate the number of interrogators within 4 nmi. There are no 2-digit numerals).

segments were contained within a precursor, and did not elicit replies.[a] The remaining two Comm-C segments which serve to finalize the ELM transaction each elicited an ELM Comm-D reply.

Fourteen percent of the aircraft population (DABS-equipped) received mid-option CDTI or standard data link services that consisted of ((T/2) ru + P) Comm-A interrogations per scan, where P is a random variable of Poisson distribution with a mean of 1.0. Each Comm-A transmission contained data for two targets. All but one of the Comm-A interrogations elicited surveillance (altitude or identity) replies. The remaining Comm-A interrogation elicited a mid-option CDTI finalizing Comm-B reply. If both T and P for a particular aircraft were computed to be zero, the A/C received one surveillance interrogation per scan from its primary sensor.

In addition, each DABS-equipped aircraft received one DABS surveillance interrogation per scan from its secondary sensor.

TABLE 5

DABS SENSOR SURVEILLANCE AND DATA LINK ZONE ASSIGNMENTS
(see Figure 1)

| Site | Surveillance Responsibility Primary | Surveillance Responsibility Secondary | Data Link Responsibility |
|---|---|---|---|
| Burbank | A | B | A |
| Los Angeles | B | C | B |
| El Toro | C | D | C |
| Ontario | D | A | D |

[a]Comm-C segments that do not elicit replies are transmitted at the beginning of the DABS interrogation schedule and thus are referred to as the precursor. (See Reference 7.)

## TCAS/ATC COMPATIBILITY DESIGN

### Ground-Based Radar Beacon Transponders (RBX)

In addition to the airborne transponder deployment described above, 20 FAA terminal sites were assumed to have RBX units located on the ground approximately 1 nmi from the ATC interrogator. The locations are given in APPENDIX A, Figure A-9. The characteristics of the RBX units as modeled are listed in TABLE 6. RBX-TCAS surveillance loading is discussed in Appendix D.

TABLE 6

RBX CHARACTERISTICS

| | |
|---|---|
| Power | 4.0 kW (at transmitter) |
| Receiver Sensitivity (MTL) | -87.0 dBm |
| Cabling Loss | 3.0 dB |
| Peak Antenna Gain[a] | 6.0 dBi |

[a]The RBX antenna is omnidirectional in azimuth. (Added in proof. The TCAS concept does not use the RBX and considerations of deploying such a unit have been discontinued.)

### Interference-Limiting

Each TCAS unit incorporates an interference-limiting function to ensure that TCAS-generated interrogations will not cause excessive interference to other systems, particularly the Air Traffic Control ground systems. Interference-limiting is achieved in this analysis by reducing a TCAS unit's output power and receiver threshold (MTL) in 6 dB steps, and by eliminating the high-power ATCRBS interrogation from the "Whisper-Shout" sequence[a] to maintain the inequality:

$$\frac{(B+1)}{250}\,10^{(MTL+74)}\left(DP_d + S\sum_{i=1}^{n} P_i\right) \leq 570 \quad \text{interrogations/second} \quad (1)$$

[a]See Reference 5 and APPENDIX D

where

| | | |
|---|---|---|
| B | = | number of TCAS equipped aircraft detected by squitter |
| D | = | DABS interrogation rate (per second) |
| S | = | ATCRBS interrogation Whisper-Shout cycles per second = 1/(second) |
| $P_d$ | = | DABS power (watts at antenna) |
| $P_i$ | = | ATCRBS power (watts at antenna) |
| n | = | number of Whisper-Shout levels |
| MTL | = | receiver threshold (dBm at antenna). Note that this MTL adjustment is restricted to the 1090-MHz TCAS receiver channel. MTL at the 1030-MHz Mode S transponder is a constant (-77 dBm). |

If the inequality cannot be satisfied after power is reduced by 12 dB, the TCAS will cease to transmit interrogations. The interference-limiting modeling procedures are discussed in APPENDIX D. APPENDIX C lists the interference-limiting state (permissible transmission power) of each TCAS interrogator for each of the aircraft deployments. In addition, APPENDIX C contains figures illustrating the locations of the TCAS units that were required to limit CAS activity for each of the simulations. TABLE 7 gives TCAS interrogator characteristics.

TABLE 7

TCAS INTERROGATOR CHARACTERISTICS

| | |
|---|---|
| Power | $P_t$[a] (at transmitter) |
| Receiver Sensitivity (MTL) (1090-MHz channel) | $R_s$[b] |
| Cable Loss | 3 dB |
| Peak Antenna Gain (omnidirectional in azimuth) | 2.5 dBi |

[a] $P_t = (0.5/4^N)$ kW, were N is the number of 6 dB power reductions required to satisfy the interference-limiting inequality.

[b] $R_S = (-77 + (N \times 6.0))$ dBm, where N is the number of 6 dB sensitivity reductions required to satisfy the interference-limiting inequality.

# SECTION 3
# DISCUSSION OF RESULTS

## GENERAL

Performance of all transponders within range of the interrogator-of-interest ($I_o$) was assessed in terms of the suppression rate, interrogation rate, and reply probability. The performance of the ATCRBS ground system was evaluated in terms of ATCRBS fruit rate, DABS fruit rate, and ARTS III target detection and code validation probabilities. The performance of the DABS ground system was evaluated in terms of ATCRBS fruit rate, DABS fruit rate, DABS roll-call transactions, and ATCRBS target detection and code confidence.

It should be emphasized that although system parameters such as interrogation rates, suppression rates, and reply probabilities are useful and meaningful transponder performance indicators, the parameters of primary significance are those defining the ability of the ground system to perform its fundamental air traffic control function of reliably detecting aircraft.

## LONG BEACH ATCRBS

Performance measures of the Long Beach ATCRBS ground receiver, with and without TCAS, and with and without interference limiting, are shown in TABLES B-1 through B-14, of APPENDIX B.[a] Results for the four levels of aircraft densities (0.159, 0.08, 0.04, and 0.02 A/C per square nmi) with a 25% DABS (11% TCAS) and 75% ATCRBS transponder distribution are given. Other variations of transponder distributions and aircraft densities were also analyzed. These were: a 25% DABS (25% TCAS) transponder distribution in aircraft densities of 0.159, and 0.08 A/C per square nmi, and a 54% DABS (25% TCAS) distribution in a 0.08 density. The location, interrogation rate, and transmission power of each TCAS unit for each simulation are listed in

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[a]The results in APPENDIX B are given in terms of quadrant averages about the Long Beach interrogator.

APPENDIX C. The results discussed below are based on a 1-scan (4.6-second) simulation of the victim antenna for each aircraft deployment.

Transponder Performance

The average probability of reply was computed by dividing the total number of transponder replies to Long Beach interrogations during a complete 360° scan of the mainbeam by the total number of Long Beach interrogations in the same scan. Each aircraft received approximately 21 ATCRBS interrogations.

TABLE 8 gives the performance of transponders within 60 nmi of the Long Beach interrogator, both with and without TCAS (and with and without interference-limiting). It can be seen that TCAS activity without interference-limiting reduced the average transponder probability of reply by more than 2% for the full-scale deployment (0.159 aircraft per square nmi) for both the distribution of 25% DABS (11% TCAS) and the 25% DABS (25% TCAS) distribution. This reduction is caused by both the increased ATCRBS interrogation rate and the increase in effective sidelobe suppression rate associated with TCAS activity.[a] With TCAS employing interference-limiting, the degradation in average probability of reply was 1% for both the 25% DABS (11% TCAS) and the 25% DABS (25% TCAS) distributions.

For the three reduced air traffic densities, the reduction in average reply probability was greater than 2% only in the aircraft density of 0.08 A/C per square nmi with 54% DABS (25% TCAS). Again, interference-limiting reduced this effect to 1%.

Also included in TABLE 8 are the standard deviations of the ATCRBS interrogation rate, the effective suppression rate, and the probability of reply for each simulation. The magnitudes of these quantities indicate a wide variation about their mean values.

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[a]The effective sidelobe suppression rate is the sum of the actual sidelobe suppression rate and the misaddressed roll-call interrogation rate.

TABLE 8

SUMMARY OF EFFECTS OF TCAS ON ALL TRANSPONDERS RESPONDING TO LONG BEACH ATCRBS INTERROGATIONS

| DEPLOYMENT | A | | | E | | | B | | | F | | | G | | | C | | | D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A/C DENSITY | .159 | | | .159 | | | .08 | | | .08 | | | .08 | | | .04 | | | .02 | | |
| TOTAL # of A/C | 716 | | | 716 | | | 376 | | | 376 | | | 376 | | | 196 | | | 90 | | |
| % DABS (% TCAS) | 25 (11) | | | 25 (25) | | | 25 (11) | | | 25 (25) | | | 54 (25) | | | 25 (11) | | | 25 (11) | | |
| % ATCRBS | 75 | | | 75 | | | 75 | | | 75 | | | 46 | | | 75 | | | 75 | | |
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS Interference Limiting | |
| | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off |
| Average ATCRBS Interrogation Rate | 234 | 268 | 302 | 234 | 287 | 394 | 230 | 260 | 260 | 230 | 281 | 303 | 253 | 297 | 342 | 244 | 244 | 244 | 240 | 260 | 260 |
| (Standard Deviation) | (252) | (252) | (254) | (252) | (254) | (268) | (239) | (238) | (238) | (239) | (243) | (246) | (275) | (278) | (279) | (225) | (247) | (247) | (245) | (223) | (223) |
| Average Effective Suppression Rate | 565 | 726 | 1599 | 565 | 745 | 2976 | 564 | 723 | 723 | 564 | 707 | 982 | 661 | 850 | 2006 | 528 | 543 | 543 | 543 | 548 | 548 |
| (Standard Deviation) | (490) | (508) | (786) | (490) | (496) | (1347) | (482) | (521) | (521) | (482) | (507) | (583) | (496) | (498) | (785) | (472) | (477) | (477) | (477) | (472) | (472) |
| Average Probability of Reply | .969 | .960 | .931 | .969 | .959 | .880 | .969 | .962 | .962 | .969 | .961 | .953 | .963 | .953 | .918 | .963 | .969 | .969 | .970 | .962 | .962 |
| (Standard Deviation) | (.038) | (.043) | (.059) | (.038) | (.043) | (.082) | (.037) | (.042) | (.042) | (.037) | (.042) | (.045) | (.043) | (.047) | (.063) | (.044) | (.038) | (.038) | (.038) | (.044) | (.044) |

It can be seen that, even without TCAS activity, increasing the percentage of aircraft that are DABS-equipped resulted in an increased average interrogation rate and an increased average effective suppression rate (compare 0.08 density 25% DABS (11% TCAS) and 25% DABS (25% TCAS) simulations with 0.08 density 54% DABS (25% TCAS) simulations). This is explained by noting that the sensitivity (MTL) of a DABS-equipped aircraft as -77 dBm while an ATCRBS-equipped aircraft's sensitivity is -74 dBm.

## Interrogator Performance

The effects of TCAS on the ATCRBS interrogator performance are summarized in TABLE 9 and discussed below.

Fruit Rates. The two types of fruit arriving at the Long Beach interrogator receiver are defined as follows:

- ATCRBS fruit. ATCRBS replies elicited by ATCRBS and TCAS interrogators other than the Long Beach interrogator.
- Roll-Call fruit. DABS replies elicited by TCAS roll-call interrogations.

ATCRBS transponder replies to the active ATCRBS mode of TCAS result in increased levels of ATCRBS fruit at the ground receiver. For TCAS operating without interference-limiting, these levels varied from a 3.7% increase in ATCRBS fruit for the 0.02 aircraft density, to 57% for the 0.159 aircraft density with 25% DABS (25% TCAS).[a] With interference-limiting, the 57% increase was reduced to a 16% increase.

DABS transponder replies associated with TCAS operation result in DABS roll-call fruit at the ground receiver. The ATCRBS interrogator receivers are assumed to be blanked out to ATCRBS replies for the duration of a DABS reply (64 μs). The full-scale deployment simulation with 25% DABS (25% TCAS)

[a]The increased fruit rates are due to the increased ATCRBS interrogation rates associated with TCAS activity.

TABLE 9

SUMMARY OF EFFECTS OF TCAS ON ATCRBS INTERROGATOR PERFORMANCE AT LONG BEACH

| DEPLOYMENT | A | | | E | | | B | | | F | | | G | | | C | | | D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A/C DENSITY | .159 | | | .159 | | | .08 | | | .08 | | | .08 | | | .04 | | | .02 | | |
| TOTAL # of A/C | 716 | | | 716 | | | 376 | | | 376 | | | 376 | | | 196 | | | 90 | | |
| % DABS (% TCAS) | 25 (11) | | | 25 (25) | | | 25 (11) | | | 25 (25) | | | 54 (25) | | | 25 (11) | | | 25 (11) | | |
| % ATCRBS | 75 | | | 75 | | | 75 | | | 75 | | | 46 | | | 75 | | | 75 | | |
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off |
| ATCRBS Fruit Per Second | 7462 | 8284 | 9304 | 7462 | 8664 | 11714 | 3676 | 4093 | 4093 | 3677 | 4445 | 4775 | 4139 | 4581 | 4930 | 1749 | 1842 | 1842 | 461 | 478 | 478 |
| DABS Roll Call Fruit Per Second | - | 37 | 85 | - | 48 | 176 | - | 18 | 18 | - | 13 | 36 | - | 22 | 73 | - | 3 | 3 | - | 1 | 1 |
| Reduction in Target Detection Probability(%) | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 |
| Reduction in Mode A Validation Probability(%) | - | 0.2 | 0.4 | - | 0.5 | 1.5 | - | 0.3 | 0.3 | - | 0.3 | 0.3 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 |
| Reduction in Mode C Validation Probability(%) | - | 0 | 0.2 | - | 0.3 | 1.9 | - | 0.3 | 0.3 | - | 0.3 | 0.3 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 |

resulted in 176 roll-call fruit/s or (1.1% receiver blanking) without limiting, and 48 roll-call fruit/s (0.3% receiver blanking) with limiting. Other variations of DABS roll-call fruit, including those for the reduced deployments, are given in TABLE 9.

Target Detection and Code Validation. Deploying TCAS (with or without interference-limiting) did not degrade the ability of the ARTS III processor to detect aircraft. For the full-scale deployment of 0.159 aircraft per square nmi and the distribution of 25% DABS (25% TCAS), a 1.5% reduction of Mode A and a 1.9% reduction in Mode C validation is predicted without interference-limiting. Interference-limiting will reduce the effect to 0.5% and 0.3% for Mode A and Mode C, respectively. For the reduced air traffic environments (0.08, 0.04, and 0.02 aircraft per square nmi), TCAS operation resulted in less than a 1% reduction to mode-validation probabilities.

## LOS ANGELES DABS

DABS performance at LAX-4, with and without TCAS, and with and without TCAS employing its interference-limiting is given (in terms of quadrant averages about LAX-4) in TABLES B-15 through B-28 in APPENDIX B. The location, interrogation rate, and transmission power of each TCAS unit for each simulation are listed in APPENDIX C. These results (discussed below) are based on a 1-scan (4.6-second) simulation of the victim antenna for each aircraft deployment.

### Transponder Performance

The average transponder probability of reply was computed by dividing the total number of DABS and ATCRBS replies during a complete 360° scan of the mainbeam by the total number of LAX-4 interrogations. Each ATCRBS-equipped aircraft received approximately six ATCRBS-Only interrogations per scan. DABS-equipped transponders received a variable number of discrete interrogations from the LAX-4 DABS sensor (see Section 2).

TABLE 10 gives the performance of ATCRBS-equipped transponders within 60 nmi of the Los Angeles sensor, both with and without TCAS (and with and without TCAS employing interference-limiting). It can be seen that with TCAS (without interference-limiting), the reduction in average transponder probability of reply exceeded 2% for the full-scale air traffic environment for both the distribution of 25% DABS (11% TCAS) and the 25% DABS (25% TCAS) distribution. Again, this is caused by the increased ATCRBS interrogation rate and the increased effective suppression rate (sidelobe suppressions rate plus misaddressed roll-call interrogation rate) associated with TCAS transmissions. With TCAS employing its interference-limiting function, the degradation in average reply probability was reduced to less than 1% for both distributions.

For the reduced air traffic deployments, the reduction in average reply probability due to TCAS operation (without interference-limiting) was greater than 2% only for the 54% DABS (25% TCAS) distribution in the 0.08 A/C per square nmi deployment. With TCAS employing interference limiting, the degradation in average reply probability was reduced to about 1%.

## Sensor Performance

The effects of TCAS on the DABS sensor performance are summarized in TABLE 11 and discussed below.

Fruit Rates. With TCAS deployed, the increase in ATCRBS fruit varied from less than 4% in the least-dense aircraft environment (0.02 aircraft per square nmi) to about 55% in the full-scale deployment for the 25% DABS (25% TCAS) distribution. With interference-limiting, the 55% increase was reduced to a 23% increase. The roll-call fruit rate ranged from 43/s with the full-scale air traffic deployment for the distribution of 25% DABS (25% TCAS) to zero with the least-dense (0.02 aircraft per square nmi) air traffic configuration.

TABLE 10

SUMMARY OF EFFECTS OF TCAS ON ATCRBS TRANSPONDERS
RESPONDING TO LOS ANGELES ATCRBS-MODE-OF-DABS INTERROGATIONS

| DEPLOYMENT | A | | | E | | | B | | | F | | | G | | | C | | | D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A/C DENSITY | .159 | | | .159 | | | .08 | | | .08 | | | .08 | | | .04 | | | .02 | | |
| TOTAL # of A/C | 743 | | | 743 | | | 386 | | | 386 | | | 386 | | | 201 | | | 92 | | |
| % DABS ( % TCAS) | 25 (11) | | | 25 (25) | | | 25 (11) | | | 25 (25) | | | 54 (25) | | | 25 (11) | | | 25 (11) | | |
| % ATCRBS | 75 | | | 75 | | | 75 | | | 75 | | | 46 | | | 75 | | | 75 | | |
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off |
| Average ATCRBS Interrogation Per Second | 236 | 272 | 308 | 236 | 292 | 400 | 219 | 251 | 251 | 219 | 269 | 293 | 248 | 287 | 332 | 220 | 237 | 237 | 229 | 239 | 239 |
| (Standard Deviation) | (240) | (245) | (249) | (240) | (250) | (265) | (214) | (220) | (220) | (214) | (224) | (227) | (259) | (232) | (268) | (210) | (213) | (213) | (208) | (213) | (213) |
| Average Effective Suppression Per Second | 398 | 559 | 1432 | 398 | 578 | 2808 | 375 | 533 | 533 | 375 | 518 | 794 | 376 | 742 | 1699 | 366 | 395 | 395 | 341 | 342 | 342 |
| (Standard Deviation) | (349) | (418) | (865) | (349) | (407) | (1528) | (332) | (407) | (407) | (332) | (385) | (520) | (337) | (450) | (776) | (326) | (340) | (340) | (315) | (315) | (315) |
| Average Probability of Reply | .965 | .959 | .931 | .965 | .960 | .883 | .975 | .966 | .966 | .975 | .968 | .957 | .967 | .954 | .912 | .972 | .970 | .970 | .964 | .964 | .964 |
| (Standard Deviation) | (.070) | (.078) | (.105) | (.070) | (.076) | (.132) | (.066) | (.078) | (.078 | (.066) | (.074) | (.081) | (.074) | (.103) | (.117) | (.062) | (.053) | (.063) | (.065) | (.065) | (.065) |

ATCRBS Mode of DABS Target Detection and Code Confidence. All ATCRBS transponder-equipped aircraft were detected and processed with high Mode A code confidence for all simulations with and without TCAS. For the full-scale deployment, without interference-limiting, less than a 1% reduction in Mode C validation is predicted. With interference-limiting, this effect is eliminated. For the reduced air traffic environments (0.08, 0.04, and 0.02 aircraft per square nmi), TCAS operation did not affect code confidence.

DABS Surveillance and Data-Link Performance. All DABS transponder-equipped aircraft were detected for all simulations, with and without TCAS. The DABS sensor at Los Angeles made 323 roll-call type interrogations to DABS-equipped aircraft in its coverage zones during a single scan, without TCAS operating in the 0.08 air traffic density with the 54% DABS (25% TCAS) distribution. With TCAS in the environment, operating with and without interference-limiting, the DABS sensor transmitted 2 and 17 additional interrogations, respectively, during those simulations. The DABS roll-call interrogation rates for each simulation are listed in TABLE 11.

TABLE 11

SUMMARY OF EFFECTS OF TCAS ON DABS SENSOR PERFORMANCE AT LOS ANGELES

| DEPLOYMENT | A | | | E | | | B | | | F | | | G | | | C | | | D | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A/C DENSITY | .159 | | | .159 | | | .08 | | | .08 | | | .08 | | | .04 | | | .02 | | |
| TOTAL # of A/C | 743 | | | 743 | | | 386 | | | 386 | | | 386 | | | 201 | | | 92 | | |
| % DABS ( % TCAS ) | 25 (11) | | | 25 (25) | | | 25 (11) | | | 25 (25) | | | 54 (25) | | | 25 (11) | | | 25(11) | | |
| % ATCRBS | 75 | | | 75 | | | 75 | | | 75 | | | 46 | | | 75 | | | 75 | | |
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off |
| ATCRBS Fruit Per Second | 1875 | 2024 | 2381 | 1875 | 2311 | 2909 | 916 | 1042 | 1042 | 916 | 1123 | 1204 | 973 | 1127 | 1237 | 479 | 513 | 513 | 226 | 234 | 234 |
| DABS All-Call Fruit Per Second | 5 | 5 | 5 | 5 | 5 | 5 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| DABS Roll-Call Fruit Per Second | 3 | 11 | 22 | 3 | 15 | 43 | 2 | 4 | 4 | 2 | 6 | 8 | 3 | 11 | 22 | 2 | 2 | 2 | 0 | 0 | 0 |
| Reduction in Target Detection Probability | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reduction in High-Confidence Mode A Decision (%) | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 |
| Reduction in High-Confidence Mode C Decision (%) | - | 0 | 0 | - | 0 | 0.9 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 | - | 0 | 0 |
| Roll-Call Interrogations Per Scan from DABS Sensor | 505 | 506 | 519 | 505 | 509 | 525 | 205 | 206 | 206 | 205 | 208 | 212 | 323 | 325 | 340 | 80 | 81 | 81 | 21 | 21 | 21 |

# SECTION 4
# CONCLUSIONS

## ATCRBS PERFORMANCE AT LONG BEACH

Deploying TCAS, with or without interference-limiting, in any of the various air traffic deployments:

1. Will not reduce target detection probabilities.
2. Will reduce the Mode A validation probability by less than 2%.
3. Will reduce the Mode C validation probability by less than 2%.

Deploying TCAS, with interference-limiting, in any of the various air traffic deployments will reduce average transponder reply probability by less than 2%.

## DABS PERFORMANCE AT LOS ANGELES

Deploying TCAS, with or without interference-limiting, in any of the various air traffic deployments:

1. Will not reduce the target detection probability.
2. Will not reduce the high-confidence Mode A validation probability.
3. Will not reduce the high-confidence Mode C validation probability by less than 1%
4. Will increase the roll-call interrogation rate by less than 6%.

Deploying TCAS, with interference-limiting, in any of the various air traffic deployments, will not reduce the high confidence Mode C validation probability and will reduce the average transponder reply probability by less than 2%.

For the peak air traffic deployment simulation (743 aircraft within 60 nmi of Los Angeles) with approximately 25% of the aircraft equipped with TCAS, it was shown that 133 of the 188 TCAS units were required to limit CAS transmissions; 2 of these units were required to terminate CAS activity.

# APPENDIX A

## AIRCRAFT DEPLOYMENTS

TABLES A-1 through A-8 give the aircraft range and altitude distributions about the Long Beach ATCRBS interrogator and about the Los Angeles DABS sensor for the four aircraft populations used in this study. Figures A-1 through A-8 show the aircraft distribution as viewed from LAX-4 for each of the air traffic environments. Figure A-9 shows the deployment of the ground-based RBX units.

TABLE A-1

AIRCRAFT DISTRIBUTION ABOUT LOS ANGELES

(Density = 0.159 A/C per sq. nmi; See Figure A-1)

Altitude

| Altitude (1000-foot Increments) | Number of Aircraft in Increment |
|---|---|
| 0-1 | 72 |
| 1-2 | 138 |
| 2-3 | 128 |
| 3-4 | 110 |
| 4-5 | 89 |
| 5-6 | 51 |
| 6-7 | 41 |
| 7-8 | 31 |
| 8-9 | 39 |
| 9-10 | 15 |
| 10-11 | 8 |
| 11-12 | 1 |
| 12-13 | 1 |
| 13-14 | 1 |
| 14-15 | 0 |
| 15-16 | 0 |
| 16-17 | 2 |
| 17-18 | 1 |
| 18-19 | 1 |
| 19-20 | 1 |
| 20-21 | 1 |
| 21-22 | 2 |
| 22-23 | 0 |
| 23-24 | 4 |
| 24-25 | 4 |
| 25-26 | 0 |
| 26-27 | 1 |
| 27-28 | 0 |
| 28-29 | 1 |
| 29-30 | 0 |

Range

| Range Increment (nmi) | Number of Aircraft in Increment |
|---|---|
| 0-5 | 35 |
| 5-10 | 45 |
| 10-15 | 93 |
| 15-20 | 89 |
| 20-25 | 104 |
| 25-30 | 86 |
| 30-35 | 81 |
| 35-40 | 57 |
| 40-45 | 66 |
| 45-50 | 47 |
| 50-55 | 24 |
| 55-60 | 14 |
| 60-65 | 2 |

TABLE A-2

AIRCRAFT DISTRIBUTION ABOUT LOS ANGELES

(Density = 0.08 A/C per sq. nmi; See Figure A-3)

| Altitude | | Range | |
|---|---|---|---|
| Altitude (1000-foot Increments) | Number of Aircraft in Increment | Range Increment (nmi) | Number of Aircraft in Increment |
| 0-1 | 34 | 0-5 | 20 |
| 1-2 | 77 | 5-10 | 22 |
| 2-3 | 75 | 10-15 | 47 |
| 3-4 | 58 | 15-20 | 48 |
| 4-5 | 48 | 20-25 | 49 |
| 5-6 | 17 | 25-30 | 48 |
| 6-7 | 21 | 30-35 | 42 |
| 7-8 | 17 | 35-40 | 29 |
| 8-9 | 19 | 40-45 | 38 |
| 9-10 | 5 | 45-50 | 23 |
| 10-11 | 5 | 50-55 | 15 |
| 11-12 | 1 | 55-60 | 4 |
| 12-13 | 1 | 60-65 | 1 |
| 13-14 | 0 | | |
| 14-15 | 0 | | |
| 15-16 | 0 | | |
| 16-17 | 1 | | |
| 17-18 | 0 | | |
| 18-19 | 1 | | |
| 19-20 | 0 | | |
| 20-21 | 1 | | |
| 21-22 | 1 | | |
| 22-23 | 0 | | |
| 23-24 | 1 | | |
| 24-25 | 2 | | |
| 25-26 | 0 | | |
| 26-27 | 0 | | |
| 27-28 | 0 | | |
| 28-29 | 1 | | |
| 29-30 | 0 | | |

TABLE A-3

AIRCRAFT DISTRIBUTION ABOUT LOS ANGELES
(Density = 0.04 A/C per sq. nmi; See Figure A-6)

| Altitude | | Range | |
|---|---|---|---|
| Altitude (1000-foot Increments) | Number of Aircraft in Increment | Range Increment (nmi) | Number of Aircraft in Increment |
| 0-1 | 19 | 0-5 | 10 |
| 1-2 | 42 | 5-10 | 14 |
| 2-3 | 40 | 10-15 | 20 |
| 3-4 | 33 | 15-20 | 19 |
| 4-5 | 20 | 20-25 | 22 |
| 5-6 | 6 | 25-30 | 30 |
| 6-7 | 11 | 30-35 | 22 |
| 7-8 | 5 | 35-40 | 18 |
| 8-9 | 11 | 40-45 | 22 |
| 9-10 | 4 | 45-50 | 14 |
| 10-11 | 4 | 50-55 | 6 |
| 11-12 | 0 | 55-60 | 3 |
| 12-13 | 0 | 60-65 | 1 |
| 13-14 | 0 | | |
| 14-15 | 0 | | |
| 15-16 | 0 | | |
| 16-17 | 0 | | |
| 17-18 | 0 | | |
| 18-19 | 1 | | |
| 19-20 | 0 | | |
| 20-21 | 0 | | |
| 21-22 | 1 | | |
| 22-23 | 0 | | |
| 23-24 | 0 | | |
| 24-25 | 2 | | |
| 25-26 | 0 | | |
| 26-27 | 0 | | |
| 27-28 | 0 | | |
| 28-29 | 1 | | |
| 29-30 | 0 | | |

TABLE A-4

AIRCRAFT DISTRIBUTION ABOUT LOS ANGELES
(Density = 0.02 A/C per sq. nmi; See Figure A-7)

| Altitude | | Range | |
|---|---|---|---|
| Altitude (1000-foot Increments) | Number of Aircraft in Increment | Range Increment (nmi) | Number of Aircraft in Increment |
| 0-1 | 10 | 0-5 | 2 |
| 1-2 | 13 | 5-10 | 7 |
| 2-3 | 22 | 10-15 | 12 |
| 3-4 | 15 | 15-20 | 7 |
| 4-5 | 10 | 20-25 | 6 |
| 5-6 | 2 | 25-30 | 19 |
| 6-7 | 7 | 30-35 | 15 |
| 7-8 | 2 | 35-40 | 6 |
| 8-9 | 5 | 40-45 | 8 |
| 9-10 | 1 | 45-50 | 7 |
| 10-11 | 3 | 50-55 | 0 |
| 11-12 | 0 | 55-60 | 2 |
| 12-13 | 0 | 60-65 | 1 |
| 13-14 | 0 | | |
| 14-15 | 0 | | |
| 15-16 | 0 | | |
| 16-17 | 0 | | |
| 17-18 | 0 | | |
| 18-19 | 1 | | |
| 19-20 | 0 | | |
| 20-21 | 0 | | |
| 21-22 | 1 | | |
| 22-23 | 0 | | |
| 23-24 | 0 | | |
| 24-25 | 2 | | |
| 25-26 | 0 | | |
| 26-27 | 0 | | |
| 27-28 | 0 | | |
| 28-29 | 1 | | |
| 29-30 | 0 | | |

TABLE A-5

AIRCRAFT DISTRIBUTION ABOUT LONG BEACH
(Density = 0.159 A/C per sq. nmi; See Figure A-1)

| Altitude | | Range | |
|---|---|---|---|
| Altitude (1000-foot Increments) | Number of Aircraft in Increment | Range Increment (nmi) | Number of Aircraft in Increment |
| 0-1 | 72 | 0-5 | 32 |
| 1-2 | 138 | 5-10 | 87 |
| 2-3 | 128 | 10-15 | 83 |
| 3-4 | 110 | 15-20 | 109 |
| 4-5 | 89 | 20-25 | 62 |
| 5-6 | 51 | 25-30 | 69 |
| 6-7 | 41 | 30-35 | 67 |
| 7-8 | 31 | 35-40 | 72 |
| 8-9 | 39 | 40-45 | 46 |
| 9-10 | 15 | 45-50 | 32 |
| 10-11 | 8 | 50-55 | 28 |
| 11-12 | 1 | 55-60 | 29 |
| 12-13 | 1 | 60-65 | 14 |
| 13-14 | 1 | 65-70 | 9 |
| 14-15 | 0 | 70-75 | 4 |
| 15-16 | 0 | | |
| 16-17 | 2 | | |
| 17-18 | 1 | | |
| 18-19 | 1 | | |
| 19-20 | 1 | | |
| 20-21 | 1 | | |
| 21-22 | 2 | | |
| 22-23 | 0 | | |
| 23-24 | 4 | | |
| 24-25 | 4 | | |
| 25-26 | 0 | | |
| 26-27 | 1 | | |
| 27-28 | 0 | | |
| 28-29 | 1 | | |
| 29-30 | 0 | | |

TABLE A-6

AIRCRAFT DISTRIBUTION ABOUT LONG BEACH
(Density = 0.08 A/C per sq. nmi; See Figure A-3)

| Altitude | | Range | |
|---|---|---|---|
| Altitude (1000-foot Increments) | Number of Aircraft in Increment | Range Increment (nmi) | Number of Aircraft in Increment |
| 0-1 | 34 | 0-5 | 13 |
| 1-2 | 77 | 5-10 | 42 |
| 2-3 | 75 | 10-15 | 45 |
| 3-4 | 58 | 15-20 | 61 |
| 4-5 | 48 | 20-25 | 27 |
| 5-6 | 17 | 25-30 | 43 |
| 6-7 | 21 | 30-35 | 33 |
| 7-8 | 17 | 35-40 | 39 |
| 8-9 | 19 | 40-45 | 23 |
| 9-10 | 5 | 45-50 | 17 |
| 10-11 | 5 | 50-55 | 15 |
| 11-12 | 1 | 55-60 | 18 |
| 12-13 | 1 | 60-65 | 4 |
| 13-14 | 0 | 65-70 | 5 |
| 14-15 | 0 | 70-75 | 1 |
| 15-16 | 0 | | |
| 16-17 | 1 | | |
| 17-18 | 0 | | |
| 18-19 | 1 | | |
| 19-20 | 0 | | |
| 20-21 | 1 | | |
| 21-22 | 1 | | |
| 22-23 | 0 | | |
| 23-24 | 1 | | |
| 24-25 | 2 | | |
| 25-26 | 0 | | |
| 26-27 | 0 | | |
| 27-28 | 0 | | |
| 28-29 | 1 | | |
| 29-30 | 0 | | |

TABLE A-7

AIRCRAFT DISTRIBUTION ABOUT LONG BEACH
(Density = 0.04 A/C per sq. nmi; See Figure A-6)

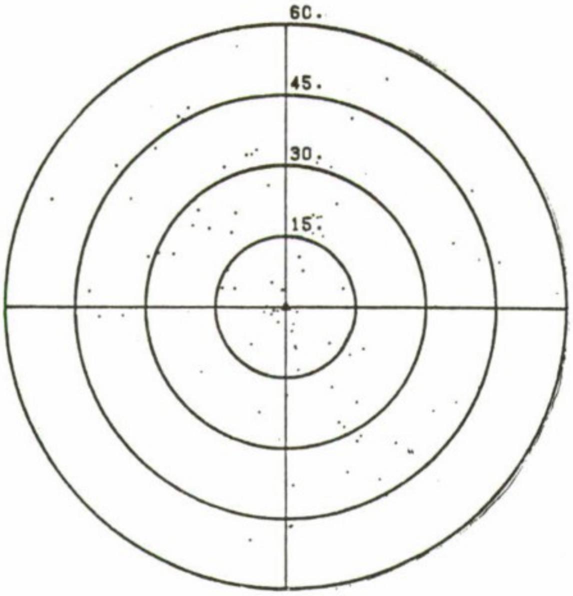
| Altitude | |
|---|---|
| Altitude (1000-foot Increments) | Number of Aircraft in Increment |
| 0-1 | 19 |
| 1-2 | 42 |
| 2-3 | 40 |
| 3-4 | 33 |
| 4-5 | 20 |
| 5-6 | 6 |
| 6-7 | 11 |
| 7-8 | 5 |
| 8-9 | 11 |
| 9-10 | 4 |
| 10-11 | 4 |
| 11-12 | 0 |
| 12-13 | 0 |
| 13-14 | 0 |
| 14-15 | 0 |
| 15-16 | 0 |
| 16-17 | 0 |
| 17-18 | 0 |
| 18-19 | 1 |
| 19-20 | 0 |
| 20-21 | 1 |
| 21-22 | 1 |
| 22-23 | 0 |
| 23-24 | 0 |
| 24-25 | 2 |
| 25-26 | 0 |
| 26-27 | 0 |
| 27-28 | 0 |
| 28-29 | 1 |
| 29-30 | 0 |

| Range | |
|---|---|
| Range Increment (nmi) | Number of Aircraft in Increment |
| 0-5 | 6 |
| 5-10 | 24 |
| 10-15 | 21 |
| 15-20 | 33 |
| 20-25 | 16 |
| 25-30 | 19 |
| 30-35 | 15 |
| 35-40 | 22 |
| 40-45 | 11 |
| 45-50 | 11 |
| 50-55 | 8 |
| 55-60 | 12 |
| 60-65 | 2 |
| 65-70 | 2 |
| 70-75 | 1 |

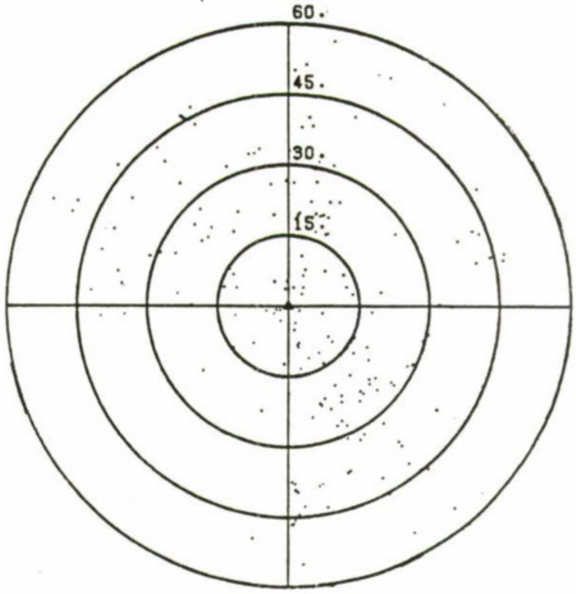
TABLE A-8

AIRCRAFT DISTRIBUTION ABOUT LONG BEACH
(Density = 0.02 A/C per sq. nmi; See Figure A-7)

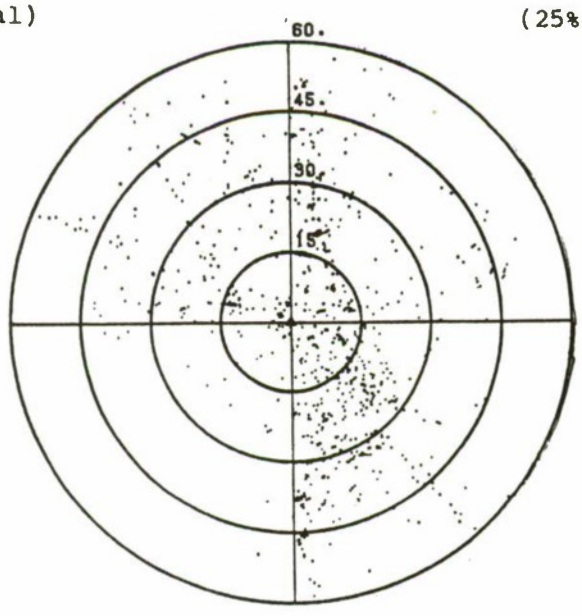
| Altitude | | Range | |
|---|---|---|---|
| Altitude (1000-foot Increments) | Number of Aircraft in Increment | Range Increment (nmi) | Number of Aircraft in Increment |
| 0-1 | 10 | 0-5 | 0 |
| 1-2 | 13 | 5-10 | 10 |
| 2-3 | 22 | 10-15 | 11 |
| 3-4 | 15 | 15-20 | 14 |
| 4-5 | 10 | 20-25 | 11 |
| 5-6 | 2 | 25-30 | 10 |
| 6-7 | 7 | 30-35 | 4 |
| 7-8 | 2 | 35-40 | 10 |
| 8-9 | 5 | 40-45 | 4 |
| 9-10 | 1 | 45-50 | 6 |
| 10-11 | 3 | 50-55 | 4 |
| 11-12 | 0 | 55-60 | 6 |
| 12-13 | 0 | 60-65 | 1 |
| 13-14 | 0 | 65-70 | 1 |
| 14-15 | 0 | | |
| 15-16 | 0 | | |
| 16-17 | 0 | | |
| 17-18 | 0 | | |
| 18-19 | 1 | | |
| 19-20 | 0 | | |
| 20-21 | 0 | | |
| 21-22 | 1 | | |
| 22-23 | 0 | | |
| 23-24 | 0 | | |
| 24-25 | 2 | | |
| 25-26 | 0 | | |
| 26-27 | 0 | | |
| 27-28 | 0 | | |
| 28-29 | 0 | | |
| 29-30 | 0 | | |




TCAS A/C
(11% of Total)

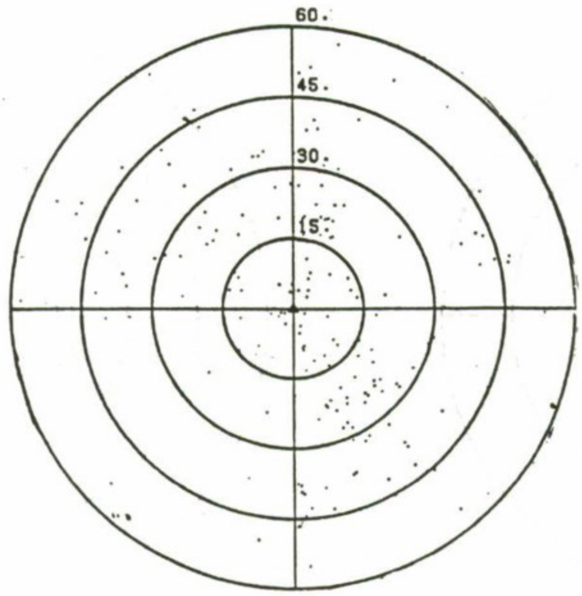



DABS A/C
(25% of Total)

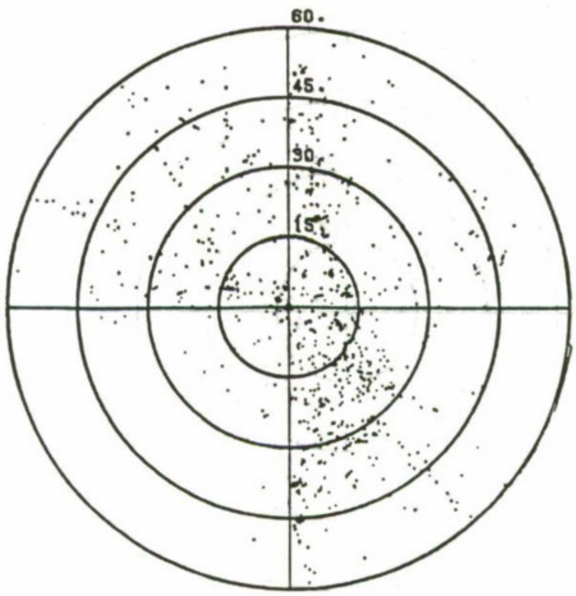



ALL A/C
(Total = 743 A/C)

Figure A-1. Distribution of aircraft about Los Angeles-Table 4 Deployment A (0.159 A/C per sq nmi to 30 nmi).

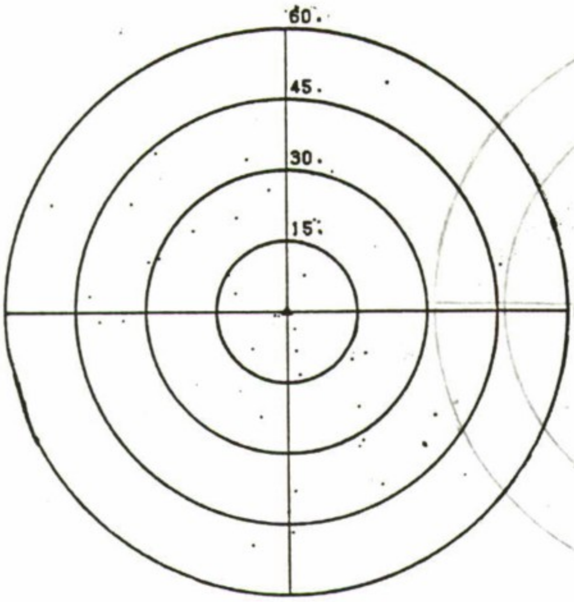



DABS/TCAS A/C
(25% of Total)

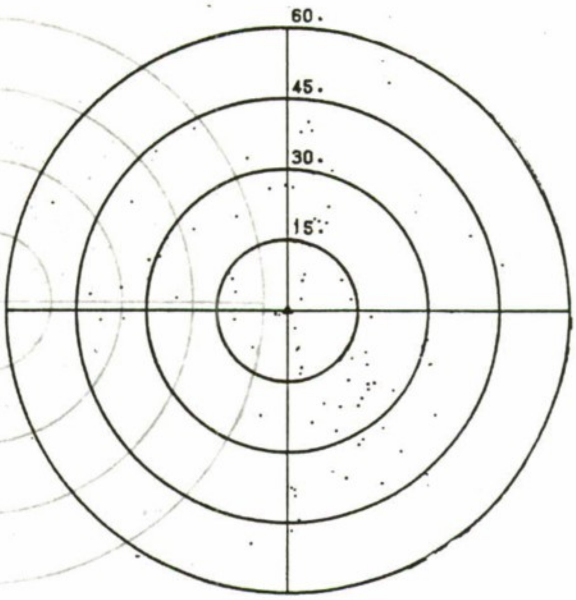



ALL A/C
(Total = 743 A/C)

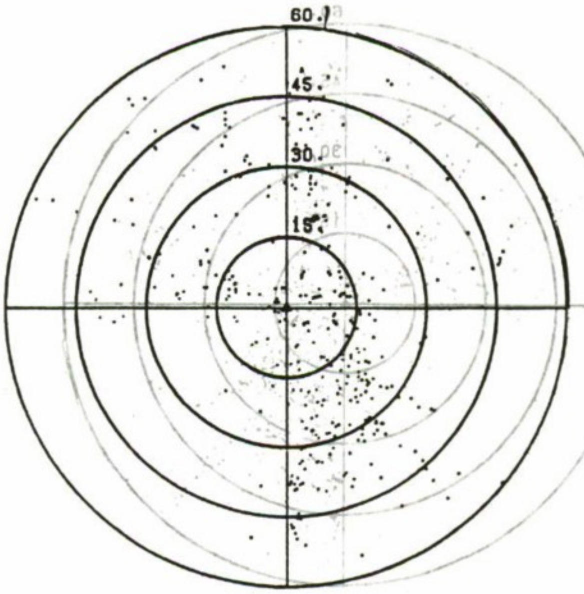
Figure A-2. Distribution of aircraft about Los Angeles-Table 4 Deployment E (0.159 A/C per sq nmi to 30 nmi).




TCAS A/C
(11% of Total)

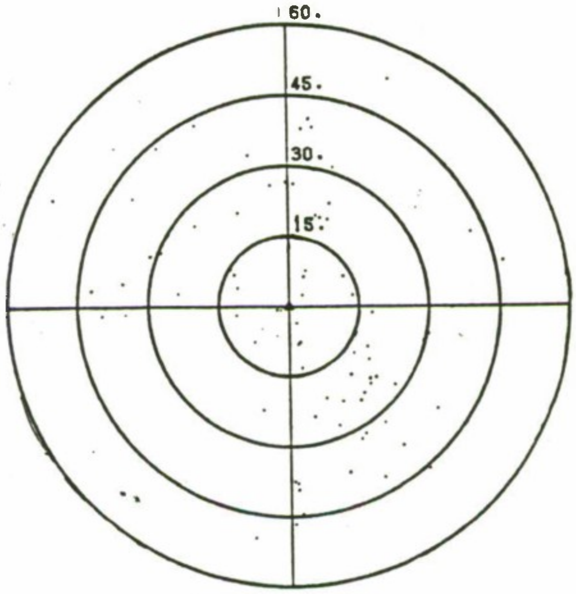



DABS A/C
(25% of Total)

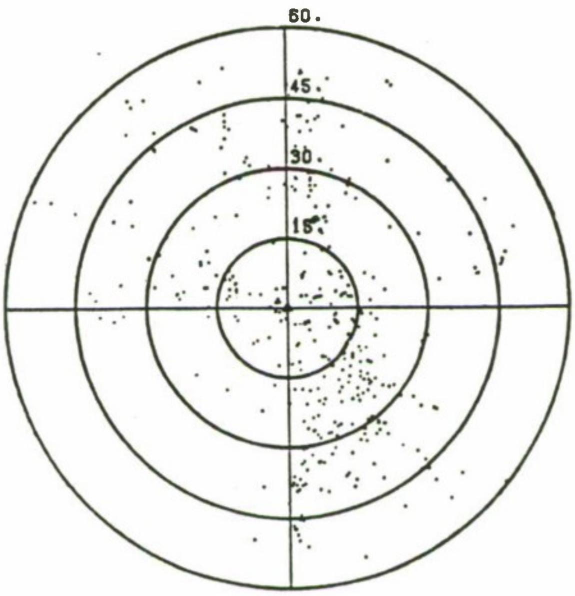



ALL A/C
(Total = 386 A/C)

Figure A-3. Distribution of aircraft about Los Angeles-Table 4 Deployment B (0.08 A/C per sq nmi to 30 nmi).

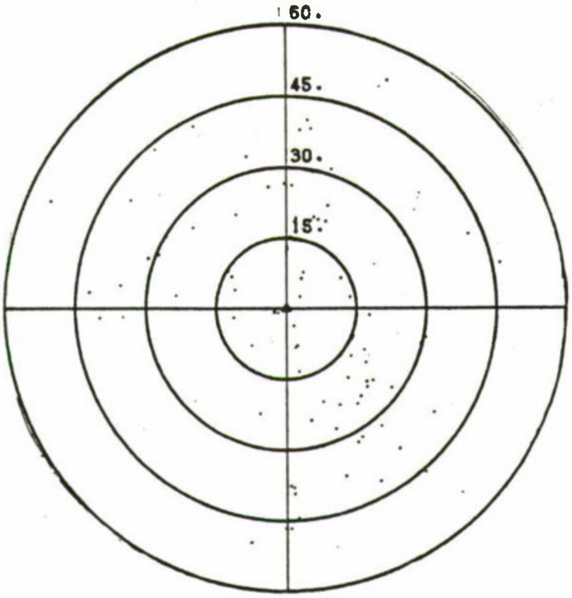



DABS/TCAS A/C
(25% of Total)

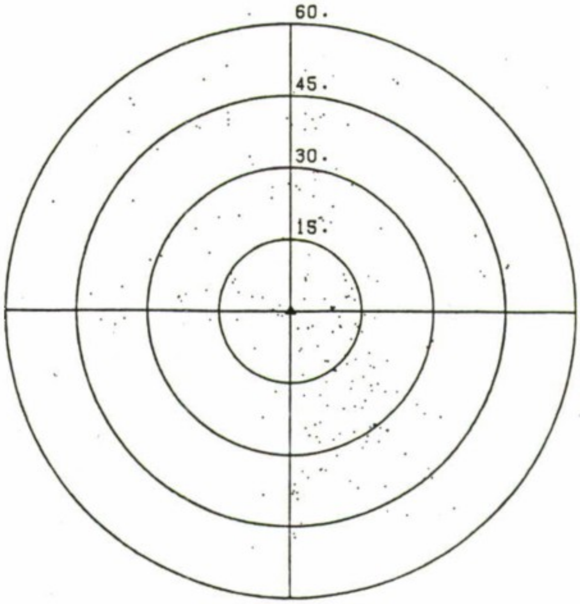



ALL AIRCRAFT
(Total = 386 A/C)

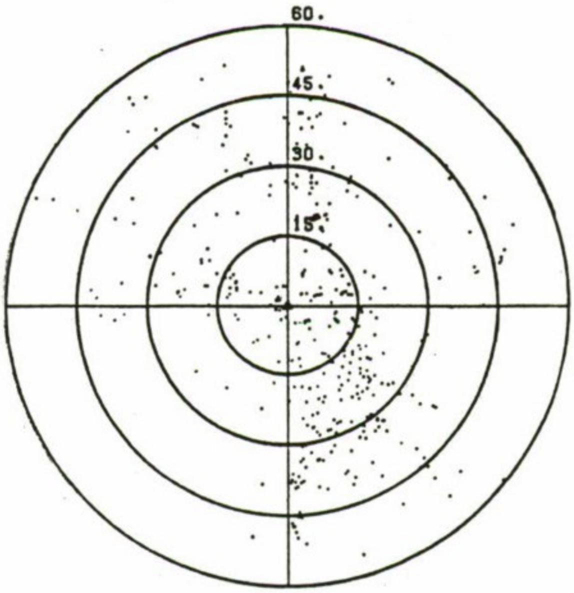
Figure A-4. Distribution of aircraft about Los Angeles-Table 4 Deployment F (0.08 A/C per sq nmi to 30 nmi).




TCAS A/C
(25% of Total)

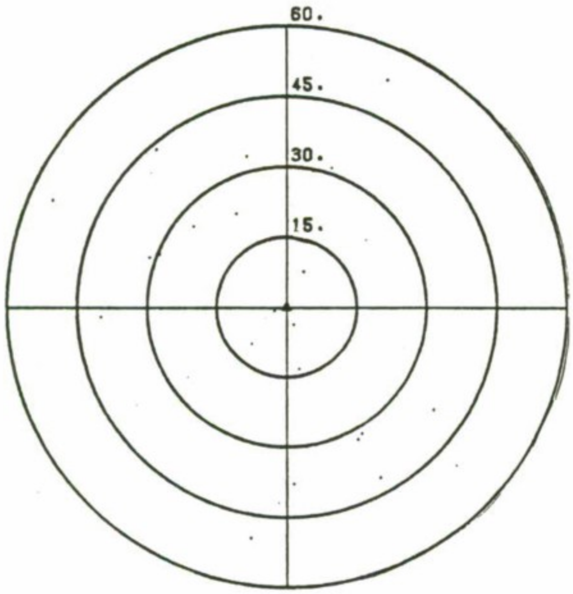



DABS A/C
(54% of Total)

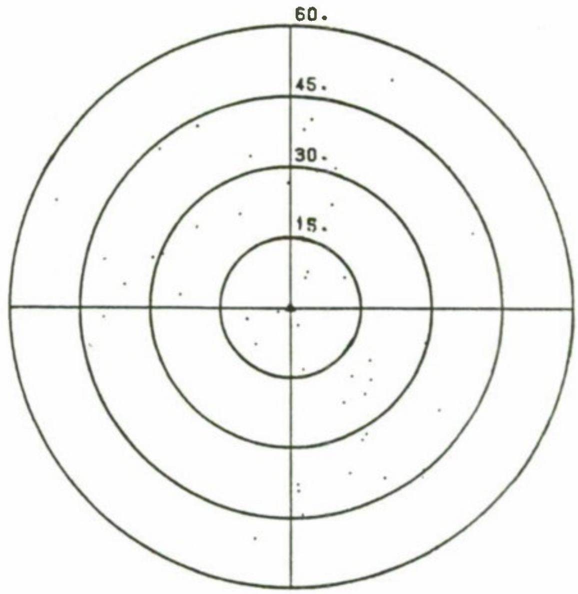



ALL A/C
(Total = 386 A/C)

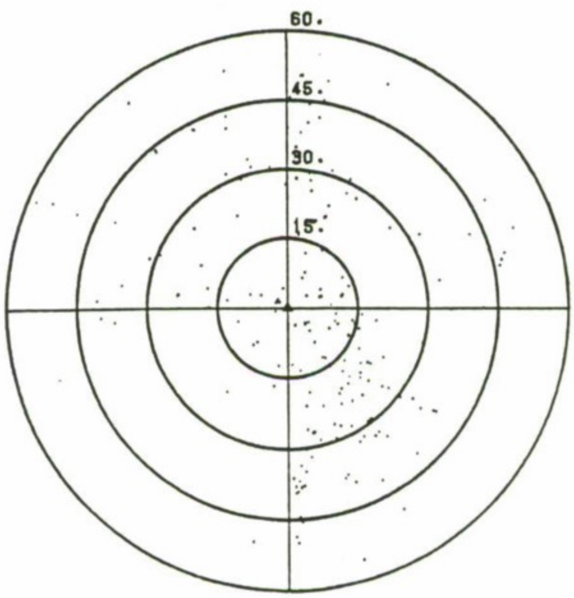
Figure A-5. Distribution of aircraft about Los Angeles-Table 4 Deployment G (0.08 A/C per sq nmi to 30 nmi).




TCAS A/C
(11% of Total)

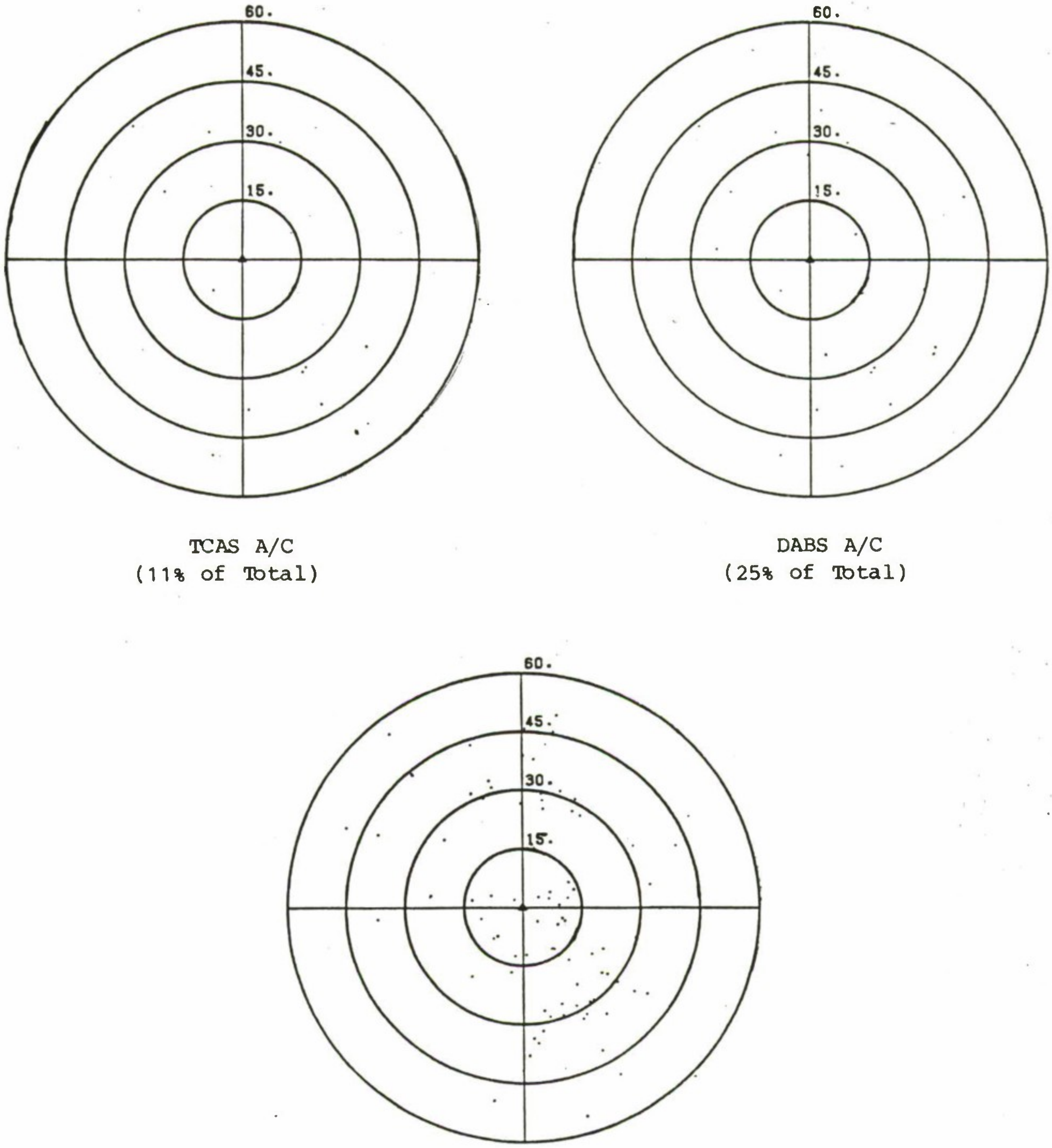



DABS A/C
(25% of Total)




ALL A/C
(Total = 201 A/C)

Figure A-6. Distribution of aircraft about Los Angeles-Table 4 Deployment C (0.04 A/C per sq nmi to 30 nmi).

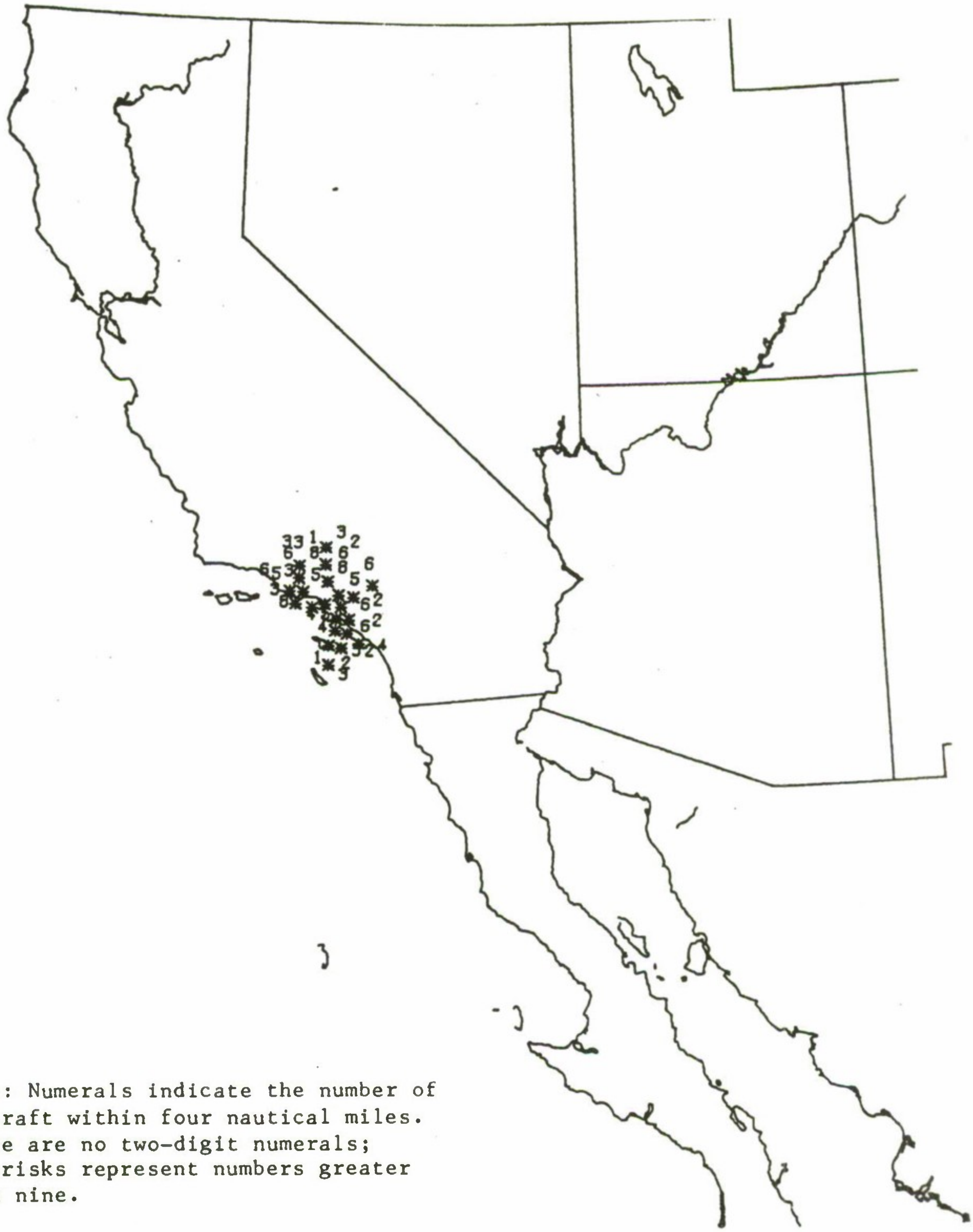



TCAS A/C
(11% of Total)

DABS A/C
(25% of Total)

ALL A/C
(Total = 92 A/C)

Figure A-7. Distribution of aircraft about Los Angeles-Table 4 Deployment D (0.02 A/C per sq nmi to 30 nmi).



Note: Numerals indicate the number of aircraft within four nautical miles. There are no two-digit numerals; asterisks represent numbers greater than nine.

Figure A-8. Los Angeles Basin air traffic deployment. Note that this figure gives the deployment on the same scale as the Figure 2 interrogator deployment on page 13 (743 A/C within 60 nmi of LAX-4).

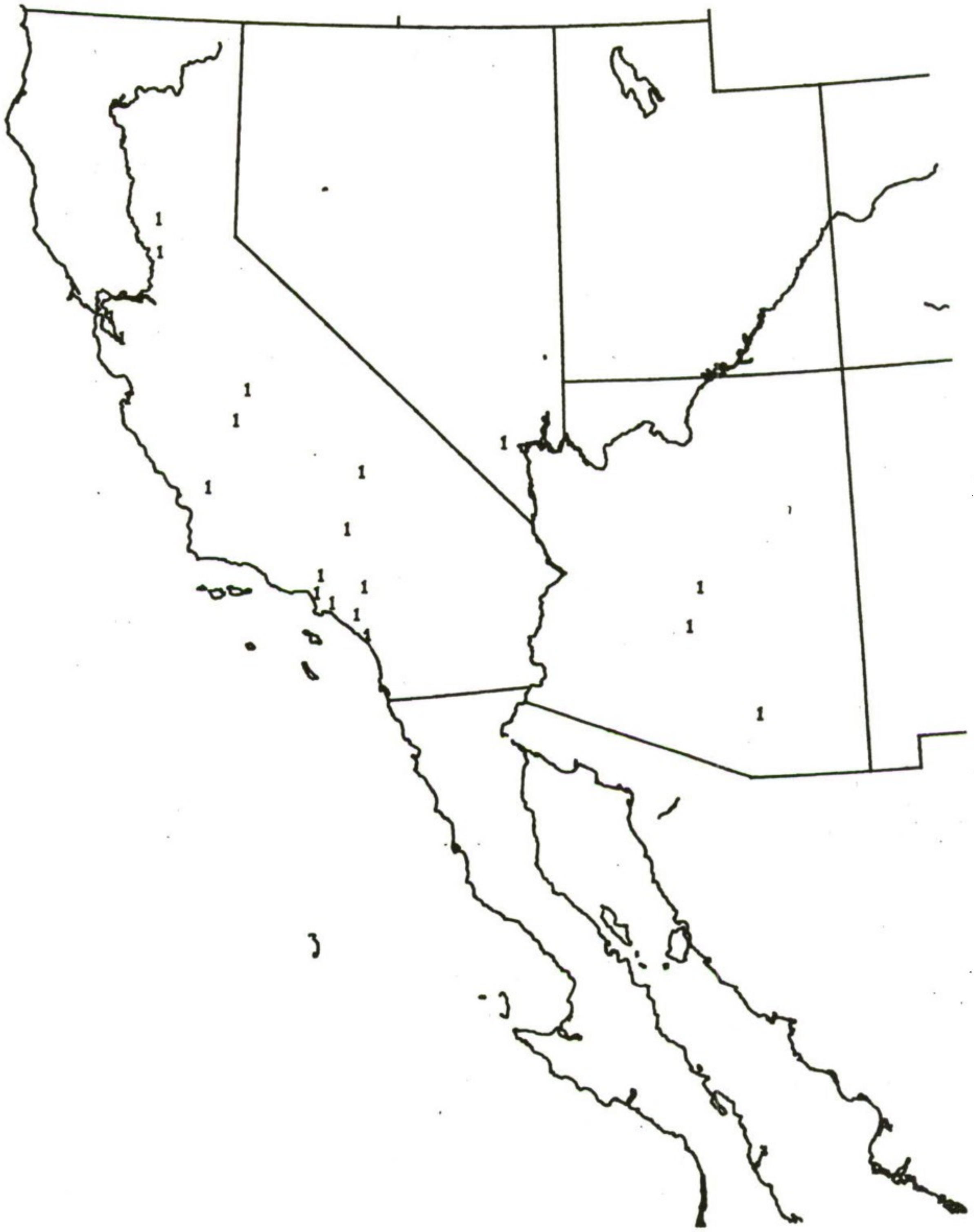


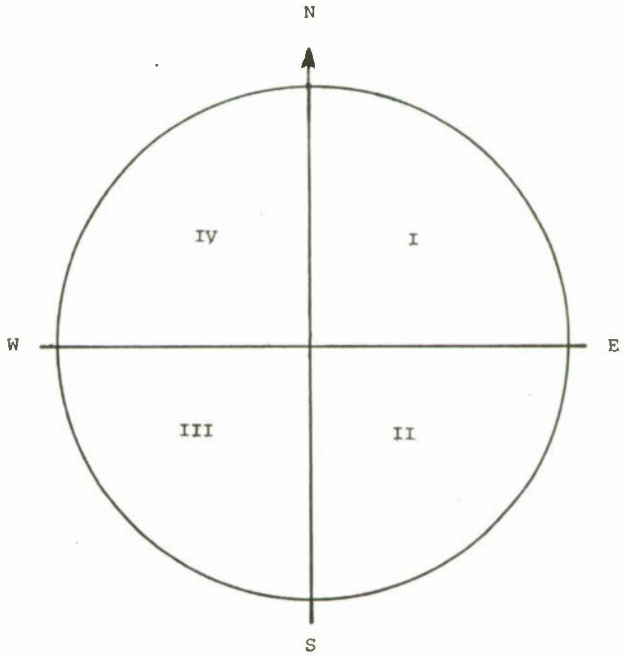
Figure A-9. RBX Deployment. One RBX at each FAA terminal site.

# APPENDIX B

## SIMULATION RESULTS

The following tables (B-1 through B-28) contain the quadrant averages (and standard deviations) of the uplink and downlink signal rates and the probability of reply for the simulations. These quantities correspond to signals transmitted (uplink) and elicited (downlink) by interrogators other than the victim interrogator.

The following convention was used for the computation of quadrant averages:




The full-scan averages are the weighted quadrant averages based on the fraction of the transponder population in each quadrant. The fraction of aircraft in each quandrant for each aircraft distribution is given below.

| DENSITY | | 0.159 | 0.08 | 0.04 | 0.02 |
|---|---|---|---|---|---|
| Interrogator | Quadrant | Percent of A/C | | | |
| | I | 9.2 | 9.2 | 5.6 | 6.6 |
| LONG | II | 18.4 | 18.9 | 20.2 | 20.2 |
| BEACH | III | 23.6 | 22.7 | 24.1 | 24.1 |
| | IV | 48.8 | 49.2 | 49.1 | 49.1 |
| | I | 25.1 | 26.3 | 26.7 | 29.1 |
| LOS | II | 48.3 | 45.4 | 48.5 | 42.6 |
| ANGELES | III | 3.7 | 4.7 | 5.3 | 8.3 |
| | IV | 22.9 | 23.6 | 19.5 | 20.0 |

The legend given below is to be used in conjunction with TABLES B-1 through B-7.

QUAD - Quadrant results (I-IV) and full scan average

ALL-CALL RATE - DABS all-call interrogations per DABS-equipped aircraft per second

ALL-CALL RATE (STD. DEV.) - DABS all-call interrogations per DABS-equipped aircraft per second standard deviation

ROLL-CALL RATE - DABS roll-call interrogations per DABS-equipped aircraft per second

ROLL-CALL RATE (STD. DEV.) - DABS roll-call interrogations per DABS-equipped aircraft per second standard deviation

ATCRBS RATE - ATCRBS interrogations per aircraft per second

ATCRBS RATE (STD. DEV.) - ATCRBS interrogations per aircraft per second standard deviation

EFF. SUPP. RATE - Effective suppressions per aircraft per second

EFF.SUPP. RATE (STD. DEV.) - Effective suppressions per aircraft per second standard deviation

PROB. OF REPLY - Probability of reply

PROB. OF REPLY (STD. DEV.) - Probability of reply standard deviation

TABLE B-1

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.159, TOTAL A/C 716, % ATCRBS 75, % DABS 25 (% TCAS 11), LONG BEACH

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 370.795 | 312.945 | 442.000 | 387.175 | .968 | .038 |
| II | .000 | .000 | .000 | .000 | 372.584 | 344.526 | 409.500 | 285.414 | .967 | .038 |
| III | .000 | .000 | .000 | .000 | 261.808 | 229.780 | 515.884 | 379.081 | .963 | .038 |
| IV | .000 | .000 | .000 | .000 | 144.731 | 154.812 | 666.701 | 580.549 | .973 | .037 |
| AVG* | .000 | .000 | .000 | .000 | 234.272 | 251.806 | 565.145 | 489.695 | .969 | .038 |
| | | | | | TCAS OFF | | | | | |
| I | .000 | .000 | .295 | 2.400 | 391.182 | 309.191 | 521.773 | 386.996 | .964 | .043 |
| II | .000 | .000 | .744 | 3.751 | 405.183 | 346.617 | 557.908 | 294.542 | .958 | .043 |
| III | .000 | .000 | .692 | 3.619 | 294.231 | 233.863 | 684.577 | 399.046 | .954 | .043 |
| IV | .000 | .000 | 1.271 | 5.249 | 182.571 | 156.462 | 843.913 | 595.454 | .963 | .043 |
| AVG* | .000 | .000 | .957 | 4.453 | 268.397 | 251.898 | 726.019 | 507.535 | .960 | .043 |
| | | | | | TCAS ON WITH INTERFERENCE LIMITING | | | | | |
| I | .000 | .000 | 2.068 | 10.335 | 423.682 | 305.971 | 1196.000 | 731.770 | .944 | .048 |
| II | .000 | .000 | 1.786 | 6.143 | 430.191 | 351.656 | 1371.847 | 567.267 | .933 | .059 |
| III | .000 | .000 | 2.423 | 8.562 | 324.115 | 239.591 | 1564.961 | 716.201 | .927 | .058 |
| IV | .000 | .000 | 3.460 | 11.748 | 220.853 | 160.248 | 1773.227 | 846.553 | .930 | .061 |
| AVG* | .000 | .000 | 2.805 | 10.162 | 301.922 | 253.544 | 1599.405 | 785.677 | .931 | .059 |
| | | | | | TCAS ON WITHOUT INTERFERENCE LIMITING | | | | | |

*AVG - Full Scan Average

TABLE B-2

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.159 , TOTAL A/C 716, % ATCRBS 75, % DABS 25 (% TCAS 25), LONG BEACH

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 370.795 | 312.945 | 442.000 | 387.175 | .968 | .038 |
| II | .000 | .000 | .000 | .000 | 372.584 | 344.526 | 409.500 | 285.414 | .957 | .038 |
| III | .000 | .000 | .000 | .000 | 261.808 | 229.780 | 515.884 | 379.081 | .963 | .038 |
| IV | .000 | .000 | .000 | .000 | 144.731 | 154.812 | 666.701 | 580.549 | .973 | .037 |
| AVG* | .000 | .000 | .000 | .000 | 234.272 | 251.806 | 565.145 | 489.695 | .969 | .038 |
| | | | | | TCAS OFF | | | | | |
| I | .000 | .000 | 1.477 | 5.199 | 409.204 | 311.409 | 555.753 | 382.404 | .961 | .044 |
| II | .000 | .000 | 1.786 | 5.647 | 426.916 | 348.518 | 601.523 | 303.417 | .959 | .040 |
| III | .000 | .000 | 1.500 | 5.629 | 312.461 | 232.505 | 696.346 | 375.814 | .954 | .042 |
| IV | .000 | .000 | 1.823 | 6.729 | 201.021 | 159.538 | 855.403 | 585.953 | .962 | .043 |
| AVG* | .000 | .000 | 1.716 | 6.165 | 287.406 | 253.551 | 745.383 | 496.275 | .959 | .043 |
| | | | | | TCAS ON WITH INTERFERENCE LIMITING | | | | | |
| I | .000 | .000 | 3.545 | 12.757 | 507.886 | 317.399 | 2368.659 | 1460.765 | .897 | .077 |
| II | .000 | .000 | 7.943 | 21.695 | 537.366 | 363.536 | 3018.033 | 1039.941 | .872 | .078 |
| III | .000 | .000 | 7.154 | 19.803 | 428.884 | 256.054 | 3131.653 | 1202.214 | .874 | .083 |
| IV | .000 | .000 | 5.745 | 15.323 | 301.504 | 171.867 | 2997.915 | 1465.532 | .883 | .083 |
| AVG* | .000 | .000 | 6.101 | 17.379 | 397.948 | 268.449 | 2975.705 | 1347.422 | .883 | .082 |
| | | | | | TCAS ON WITHOUT INTERFERENCE LIMITING | | | | | |

*ABG - Full Scan Average

TABLE B-3

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 376, % ATCRBS 75, % DABS 25 (% TCAS 11), LONG BEACH

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 336.514 | 312.549 | 483.600 | 372.241 | .970 | .036 |
| II | .000 | .000 | .000 | .000 | 369.107 | 296.873 | 447.943 | 392.475 | .966 | .039 |
| III | .000 | .000 | .000 | .000 | 248.512 | 242.970 | 484.552 | 373.303 | .963 | .041 |
| IV | .000 | .000 | .000 | .000 | 156.519 | 161.173 | 662.274 | 570.009 | .973 | .035 |
| AVG* | .000 | .000 | .000 | .000 | 229.903 | 238.796 | 564.462 | 481.899 | .969 | .037 |
| | | | | | TCAS OFF | | | | | |
| I | .000 | .000 | .557 | 3.296 | 352.671 | 311.870 | 590.571 | 449.997 | .969 | .036 |
| II | .000 | .000 | .836 | 5.181 | 398.636 | 297.935 | 591.407 | 360.736 | .956 | .047 |
| III | .000 | .000 | .907 | 4.131 | 277.762 | 243.590 | 630.122 | 441.358 | .956 | .047 |
| IV | .000 | .000 | .415 | 2.821 | 189.814 | 160.299 | 842.026 | 586.629 | .968 | .038 |
| AVG* | .000 | .000 | .570 | 3.533 | 260.242 | 237.833 | 722.848 | 520.734 | .962 | .042 |

TCAS ON WITH AND WITHOUT INTERFERENCE LIMITING

*AVG - Full Scan Average

TABLE B-4

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 376, % ATCRBS 75, % DABS 25 (% TCAS 25), LONG BEACH

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 336.514 | 312.549 | 483.500 | 372.241 | .970 | .036 |
| II | .000 | .000 | .000 | .000 | 369.107 | 295.873 | 447.943 | 302.473 | .966 | .039 |
| III | .000 | .000 | .000 | .000 | 248.512 | 242.370 | 484.552 | 373.303 | .963 | .041 |
| IV | .000 | .000 | .000 | .000 | 156.519 | 151.173 | 662.274 | 570.039 | .973 | .035 |
| AVG* | .000 | .000 | .000 | .000 | 229.903 | 238.796 | 564.462 | 481.899 | .969 | .037 |
| TCAS OFF | | | | | | | | | | |
| I | .000 | .000 | .000 | .000 | 370.500 | 312.108 | 567.729 | 428.910 | .969 | .036 |
| II | .000 | .000 | 2.786 | 8.961 | 432.900 | 301.739 | 644.893 | 366.052 | .954 | .049 |
| III | .000 | .000 | 1.587 | 6.141 | 301.343 | 245.706 | 638.738 | 428.723 | .956 | .044 |
| IV | .000 | .000 | .832 | 3.947 | 203.816 | 164.690 | 792.135 | 580.692 | .965 | .038 |
| AVG* | .000 | .000 | 1.193 | 5.290 | 283.520 | 243.703 | 707.185 | 506.827 | .961 | .042 |
| TCAS ON WITH INTERFERENCE LIMITING | | | | | | | | | | |
| I | .000 | .000 | .557 | 3.296 | 396.686 | 312.964 | 808.971 | 581.730 | .960 | .041 |
| II | .000 | .000 | 1.950 | 6.763 | 457.136 | 308.029 | 917.057 | 456.125 | .945 | .051 |
| III | .000 | .000 | .907 | 4.131 | 324.471 | 251.185 | 906.070 | 533.722 | .948 | .048 |
| IV | .000 | .000 | 1.660 | 6.478 | 224.872 | 163.763 | 1077.789 | 632.958 | .957 | .041 |
| AVG* | .000 | .000 | 1.400 | 5.790 | 303.079 | 245.969 | 981.845 | 583.341 | .953 | .045 |
| TCAS ON WITHOUT INTERFERENCE LIMITING | | | | | | | | | | |

*AVG - Full Scan Average

TABLE B-5

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 376, % ATCRBS 46, % DABS 54 (% TCAS 25), LONG BEACH

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 374.766 | 295.098 | 622.172 | 417.241 | .963 | .037 |
| II | .000 | .000 | .000 | .000 | 475.091 | 366.454 | 538.909 | 331.043 | .953 | .044 |
| III | .000 | .000 | .000 | .000 | 264.483 | 241.324 | 588.362 | 370.884 | .956 | .043 |
| IV | .000 | .000 | .000 | .000 | 137.885 | 163.918 | 748.731 | 591.032 | .970 | .042 |
| AVG* | .000 | .000 | .000 | .000 | 252.666 | 274.762 | 660.888 | 495.688 | .963 | .043 |
| TCAS OFF | | | | | | | | | | |
| I | .000 | .000 | 1.828 | 5.775 | 401.578 | 293.478 | 735.516 | 442.390 | .960 | .036 |
| II | .000 | .000 | 2.364 | 8.033 | 524.432 | 369.118 | 783.841 | 337.812 | .941 | .052 |
| III | .000 | .000 | 2.017 | 7.305 | 316.931 | 242.047 | 804.879 | 395.068 | .947 | .048 |
| IV | .000 | .000 | 2.192 | 6.872 | 179.423 | 168.238 | 916.038 | 588.129 | .961 | .045 |
| AVG* | .000 | .000 | 2.055 | 7.000 | 297.278 | 277.662 | 850.110 | 498.205 | .953 | .047 |
| TCAS ON WITH INTERFERENCE LIMITING | | | | | | | | | | |
| I | .000 | .000 | 1.828 | 5.775 | 437.531 | 291.384 | 1709.906 | 925.239 | .930 | .049 |
| II | .000 | .000 | 6.500 | 14.646 | 571.409 | 363.156 | 2064.341 | 562.993 | .904 | .059 |
| III | .000 | .000 | 3.810 | 7.777 | 355.931 | 247.342 | 1998.638 | 746.231 | .910 | .072 |
| IV | .000 | .000 | 4.962 | 12.228 | 226.269 | 173.675 | 2033.422 | 945.578 | .927 | .061 |
| AVG* | .000 | .000 | 4.722 | 11.438 | 341.611 | 278.585 | 2006.442 | 785.438 | .918 | .063 |
| TCAS ON WITHOUT INTERFERENCE LIMITING | | | | | | | | | | |

*AVG - Full Scan Average

TABLE B-6

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.04, TOTAL A/C 196, % ATCRBS 75, % DABS 25 (% TCAS 11), LONG BEACH

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 416.000 | 295.389 | 198.250 | 320.734 | .984 | .024 |
| II | .000 | .000 | .000 | .000 | 449.583 | 272.793 | 422.500 | 232.638 | .956 | .047 |
| III | .000 | .000 | .000 | .000 | 179.739 | 194.464 | 523.109 | 408.640 | .947 | .054 |
| IV | .000 | .000 | .000 | .000 | 180.587 | 149.157 | 622.728 | 552.802 | .972 | .038 |
| AVG* | .000 | .000 | .000 | .000 | 244.833 | 225.067 | 528.017 | 472.147 | .963 | .044 |

TCAS OFF

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 417.300 | 282.823 | 428.025 | 375.920 | .972 | .039 |
| II | .000 | .000 | .000 | .000 | 392.566 | 286.381 | 454.145 | 269.147 | .963 | .040 |
| III | .000 | .000 | .000 | .000 | 228.913 | 237.208 | 454.435 | 364.459 | .960 | .047 |
| IV | .000 | .000 | .000 | .000 | 158.463 | 171.212 | 651.916 | 578.669 | .974 | .034 |
| AVG* | .000 | .000 | .000 | .000 | 244.148 | 247.301 | 543.015 | 477.048 | .969 | .038 |

TCAS ON WITH AND WITHOUT INTERFERENCE LIMITING

*AVG - Full Scan Average

TABLE B-7

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.02, TOTAL A/C 90 , % ATCRBS 75, % DABS 25 (% TCAS 11), LONG BEACH

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 410.475 | 230.911 | 428.025 | 375.852 | .972 | .039 |
| II | .000 | .000 | .000 | .000 | 380.763 | 284.830 | 452.605 | 269.330 | .964 | .040 |
| III | .000 | .000 | .000 | .000 | 225.522 | 239.060 | 454.435 | 364.809 | .961 | .048 |
| IV | .000 | .000 | .000 | .000 | 158.463 | 171.212 | 651.916 | 578.543 | .974 | .034 |
| AVG* | .000 | .000 | .000 | .000 | 240.357 | 245.386 | 542.617 | 477.446 | .970 | .038 |

TCAS OFF

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | .000 | .000 | 422.500 | 231.752 | 221.000 | 321.876 | .984 | .024 |
| II | .000 | .000 | .000 | .000 | 456.083 | 269.631 | 436.583 | 238.239 | .956 | .047 |
| III | .000 | .000 | .000 | .000 | 197.543 | 195.027 | 542.609 | 439.011 | .947 | .054 |
| IV | .000 | .000 | .000 | .000 | 197.967 | 150.877 | 645.196 | 559.380 | .969 | .039 |
| AVG* | .000 | .000 | .000 | .000 | 260.003 | 222.680 | 549.167 | 472.051 | .962 | .044 |

TCAS ON WITH AND WITHOUT INTERFERENCE LIMITING

*AVG - Full Scan Average

TABLE B-8

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LONG BEACH INTERROGATOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.159, TOTAL A/C 716, % ATCRBS 75, % DABS 25 (% TCAS 11)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | | NUMBER DETECTED | | | NUMBER MODE A VALIDATED | | | NUMBER MODE C VALIDATED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off |
| I | - | 13 | 24 | 5986 | 6424 | 7033 | 68 | 68 | 68 | 62 | 62 | 61 | 58 | 58 | 58 |
| II | - | 64 | 138 | 9956 | 11244 | 13049 | 117 | 117 | 117 | 104 | 104 | 103 | 92 | 92 | 93 |
| III | - | 34 | 101 | 8769 | 9418 | 10059 | 167 | 167 | 167 | 135 | 136 | 136 | 123 | 122 | 122 |
| IV | - | 37 | 77 | 5136 | 6050 | 7078 | 322 | 322 | 322 | 237 | 235 | 235 | 206 | 207 | 205 |

TABLE B-9

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LONG BEACH INTERROGATOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.159, TOTAL A/C 716, % ATCRBS 75, % DABS 25 (% TCAS 25)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | | NUMBER DETECTED | | | NUMBER MODE A VALIDATED | | | NUMBER MODE C VALIDATED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting On | Off | TCAS OFF | TCAS ON Interference Limiting On | Off | TCAS OFF | TCAS ON Interference Limiting On | Off | TCAS OFF | TCAS ON Interference Limiting On | Off | TCAS OFF | TCAS ON Interference Limiting On | Off |
| I | - | 11 | 77 | 5986 | 6556 | 8273 | 68 | 68 | 68 | 62 | 61 | 61 | 58 | 57 | 56 |
| II | - | 87 | 294 | 9956 | 12000 | 17464 | 117 | 117 | 117 | 104 | 105 | 101 | 92 | 93 | 91 |
| III | - | 64 | 186 | 8769 | 9773 | 11906 | 167 | 167 | 167 | 135 | 135 | 135 | 123 | 122 | 120 |
| IV | - | 32 | 148 | 5136 | 6326 | 9211 | 322 | 322 | 322 | 237 | 234 | 231 | 206 | 205 | 199 |

TABLE B-10

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LONG BEACH INTERROGATOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 376, % ATCRBS 75, % DABS 25 (% TCAS 11)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | | NUMBER DETECTED | | | NUMBER MODE A VALIDATED | | | NUMBER MODE C VALIDATED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off |
| I | - | 8 | 8 | 3135 | 3426 | 3426 | 36 | 36 | 36 | 35 | 35 | 35 | 33 | 33 | 33 |
| II | - | 34 | 34 | 4889 | 5512 | 5512 | 67 | 67 | 67 | 64 | 64 | 64 | 62 | 62 | 62 |
| III | - | 11 | 11 | 4129 | 4465 | 4465 | 83 | 83 | 83 | 78 | 78 | 78 | 71 | 71 | 71 |
| IV | - | 19 | 19 | 2549 | 2968 | 2968 | 174 | 174 | 174 | 149 | 148 | 148 | 127 | 126 | 126 |

TABLE B-11

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LONG BEACH INTERROGATOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 376, % ATCRBS 75, % DABS 25 (% TCAS 25)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | | NUMBER DETECTED | | | NUMBER MODE A VALIDATED | | | NUMBER MODE C VALIDATED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off |
| I | - | 8 | 18 | 3135 | 3644 | 3927 | 36 | 36 | 36 | 35 | 35 | 35 | 33 | 33 | 33 |
| II | - | 24 | 59 | 4889 | 6137 | 6580 | 67 | 67 | 67 | 64 | 64 | 64 | 62 | 62 | 62 |
| III | - | 13 | 52 | 4129 | 4733 | 5093 | 83 | 83 | 83 | 78 | 78 | 78 | 71 | 71 | 71 |
| IV | - | 8 | 23 | 2549 | 3267 | 3501 | 174 | 174 | 174 | 149 | 148 | 148 | 127 | 126 | 126 |

TABLE B-12

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LONG BEACH INTERROGATOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 376, % ATCRBS 46, % DABS 54 (% TCAS 25)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | | NUMBER DETECTED | | | NUMBER MODE A VALIDATED | | | NUMBER MODE C VALIDATED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting On | Off | TCAS OFF | TCAS ON Interference Limiting On | Off | TCAS OFF | TCAS ON Interference Limiting On | Off | TCAS OFF | TCAS ON Interference Limiting On | Off | TCAS OFF | TCAS ON Interference Limiting On | Off |
| I | - | 11 | 27 | 3278 | 3525 | 3564 | 33 | 33 | 33 | 33 | 33 | 33 | 32 | 32 | 31 |
| II | - | 32 | 135 | 5541 | 6325 | 7105 | 59 | 59 | 59 | 57 | 57 | 57 | 53 | 53 | 53 |
| III | - | 27 | 66 | 4839 | 5226 | 5456 | 88 | 88 | 88 | 81 | 81 | 81 | 78 | 78 | 78 |
| IV | - | 19 | 64 | 2901 | 3249 | 3593 | 163 | 163 | 163 | 136 | 136 | 136 | 126 | 126 | 126 |

TABLE B-13

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LONG BEACH INTERROGATOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.04, TOTAL A/C 196, % ATCRBS 75, % DABS 25 (% TCAS 11)

| QUADRANT | OABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | | NUMBER OETECTED | | | NUMBER MODE A VALIOATED | | | NUMBER MOOE C VALIOATED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off | | On | Off | | On | Off | | On | Off |
| I | - | 0 | 0 | 1484 | 1532 | 1532 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| II | - | 3 | 3 | 2374 | 2549 | 2549 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| III | - | 0 | 0 | 2040 | 2109 | 2109 | 45 | 45 | 45 | 44 | 44 | 44 | 42 | 42 | 42 |
| IV | - | 8 | 8 | 1097 | 1179 | 1179 | 90 | 90 | 90 | 83 | 83 | 83 | 77 | 77 | 77 |

TABLE B-14

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LONG BEACH INTERROGATOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.02, TOTAL A/C 90, % ATCRBS 75, % DABS 25 (% TCAS 11)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | | NUMBER DETECTED | | | NUMBER MODE A VALIDATED | | | NUMBER MODE C VALIDATED | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off |
| I | - | 0 | 0 | 358 | 366 | 366 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| II | - | 0 | 0 | 779 | 816 | 816 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| III | - | 0 | 0 | 337 | 345 | 345 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| IV | - | 3 | 3 | 374 | 387 | 387 | 43 | 43 | 43 | 43 | 43 | 43 | 38 | 38 | 38 |

The legend given below is to be used in conjunction with TABLES B-15 through B-21.

QUAD - Quadrant results (I-IV) and full scan average

ALL-CALL RATE - DABS all-call interrogations per DABS-equipped aircraft per second

ALL-CALL RATE (STD. DEV.) - DABS all-call interrogations per DABS-equipped aircraft per second standard deviation

ROLL-CALL RATE - DABS roll-call interrogations per DABS-equipped aircraft per second

ROLL-CALL RATE (STD. DEV.) - DABS roll-call interrogations per DABS-equipped aircraft per second standard deviation

ATCRBS RATE - ATCRBS interrogations per aircraft per second

ATCRBS RATE (STD. DEV.) - ATCRBS interrogations per aircraft per second standard deviation

EFF. SUPP. RATE - Effective suppressions per aircraft per second

EFF.SUPP. RATE (STD. DEV.) - Effective suppressions per aircraft per second standard deviation

PROB. OF REPLY - Probability of reply

PROB. OF REPLY (STD. DEV.) - Probability of reply standard deviation

TABLE B-15

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.159, TOTAL A/C 743, % ATCRBS 75, % DABS 25 (% TCAS 11), LOS ANGELES

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 3.750 | 15.940 | 13.500 | 41.494 | 217.964 | 220.322 | 389.505 | 401.174 | .961 | .069 |
| II | 3.799 | 15.184 | .000 | .000 | 232.253 | 244.137 | 453.008 | 265.296 | .965 | .068 |
| III | .000 | .000 | .000 | .000 | 225.041 | 223.500 | 532.297 | 357.260 | .955 | .065 |
| IV | .000 | .000 | .000 | .000 | 257.423 | 251.551 | 262.154 | 390.162 | .971 | .074 |
| AVG* | 2.593 | 12.887 | 2.904 | 22.175 | 236.388 | 239.662 | 398.188 | 348.892 | .965 | .070 |

TCAS OFF

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 3.750 | 15.940 | 13.875 | 39.820 | 251.718 | 225.292 | 537.784 | 461.174 | .955 | .079 |
| II | 3.799 | 15.184 | 4.555 | 9.951 | 267.082 | 248.525 | 625.127 | 328.361 | .959 | .077 |
| III | .000 | .000 | 11.700 | 12.333 | 266.676 | 225.544 | 751.013 | 502.595 | .958 | .069 |
| IV | .000 | .000 | 3.734 | 7.756 | 294.231 | 261.281 | 403.500 | 458.900 | .968 | .079 |
| AVG* | 2.593 | 12.887 | 7.572 | 22.755 | 272.291 | 245.510 | 559.489 | 417.667 | .959 | .078 |

TCAS ON WITH INTERFERENCE LIMITING

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 3.750 | 15.940 | 19.875 | 42.388 | 287.056 | 228.787 | 1335.502 | 952.494 | .932 | .103 |
| II | 3.799 | 15.184 | 10.890 | 19.110 | 301.686 | 250.581 | 1563.047 | 732.596 | .928 | .111 |
| III | .000 | .000 | 11.700 | 17.750 | 316.216 | 237.100 | 1913.108 | 855.077 | .924 | .091 |
| IV | .000 | .000 | 9.543 | 15.144 | 328.731 | 269.027 | 1167.576 | 918.851 | .943 | .097 |
| AVG* | 2.593 | 12.887 | 13.330 | 27.149 | 309.168 | 249.536 | 1431.633 | 865.061 | .931 | .105 |

TCAS ON WITHOUT INTERFERENCE LIMITING

*AVG - Full Scan Average

TABLE B-16

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.159, TOTAL A/C 743, % ATCRBS 75, % DABS 25 (% TCAS 25), LOS ANGELES

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 3.750 | 15.940 | 10.500 | 41.494 | 217.964 | 220.322 | 389.505 | 401.174 | .951 | .069 |
| II | 3.799 | 15.184 | .000 | .000 | 232.253 | 244.137 | 453.008 | 265.296 | .965 | .068 |
| III | .000 | .000 | .000 | .000 | 225.041 | 223.500 | 532.297 | 357.260 | .955 | .065 |
| IV | .000 | .000 | .000 | .000 | 257.423 | 251.551 | 262.154 | 390.162 | .971 | .074 |
| AVG * | 2.593 | 12.887 | 2.904 | 22.175 | 236.388 | 239.662 | 398.188 | 348.892 | .965 | .070 |
| | | | | | TCAS OFF | | | | | |
| I | 3.750 | 15.940 | 16.500 | 44.598 | 270.822 | 228.715 | 568.667 | 459.365 | .961 | .076 |
| II | 3.799 | 15.184 | 5.825 | 11.863 | 288.724 | 253.459 | 643.218 | 316.168 | .958 | .075 |
| III | .000 | .000 | 7.800 | 9.888 | 276.689 | 229.342 | 715.703 | 459.123 | .952 | .073 |
| IV | .000 | .000 | 5.394 | 10.526 | 312.346 | 266.195 | 419.192 | 447.420 | .966 | .077 |
| AVG * | 2.593 | 12.887 | 8.920 | 25.615 | 292.263 | 250.100 | 577.703 | 406.576 | .960 | .076 |
| | | | | | TCAS ON WITH INTERFERENCE LIMITING | | | | | |
| I | 3.750 | 15.940 | 35.625 | 55.521 | 368.421 | 239.104 | 2566.080 | 1633.873 | .890 | .131 |
| II | 3.799 | 15.184 | 36.974 | 32.350 | 409.443 | 266.456 | 3258.470 | 1243.579 | .866 | .134 |
| III | .000 | .000 | 22.100 | 21.947 | 406.865 | 251.583 | 3485.756 | 1595.001 | .868 | .108 |
| IV | .000 | .000 | 12.032 | 17.980 | 395.307 | 290.666 | 2020.499 | 1532.646 | .920 | .124 |
| AVG * | 2.593 | 12.887 | 29.872 | 38.496 | 399.867 | 264.793 | 2807.837 | 1528.316 | .883 | .132 |
| | | | | | TCAS ON WITHOUT INTERFERENCE LIMITING | | | | | |

*AVG - Full Scan Average

TABLE B-17

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 386, % ATCRBS 75, % DABS 25 (% TCAS 11), LOS ANGELES

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 6.500 | 19.641 | 13.812 | 38.350 | 187.875 | 210.059 | 348.375 | 384.106 | .981 | .056 |
| II | .527 | 3.206 | .000 | .000 | 236.353 | 211.536 | 428.327 | 242.088 | .970 | .066 |
| III | .000 | .000 | .000 | .000 | 168.187 | 151.681 | 521.625 | 360.217 | .970 | .063 |
| IV | .000 | .000 | .000 | .000 | 223.807 | 231.294 | 259.705 | 374.583 | .978 | .075 |
| AVG* | 2.017 | 10.736 | 3.810 | 20.762 | 218.794 | 214.065 | 375.147 | 332.159 | .975 | .066 |

TCAS OFF

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 6.500 | 19.641 | 17.062 | 38.707 | 216.937 | 213.693 | 497.250 | 468.276 | .971 | .065 |
| II | .527 | 3.206 | 2.108 | 6.139 | 269.077 | 217.072 | 586.008 | 308.803 | .958 | .086 |
| III | .000 | .000 | 2.167 | 6.500 | 195.812 | 155.307 | 732.875 | 447.420 | .970 | .063 |
| IV | .000 | .000 | 3.079 | 7.305 | 258.818 | 241.532 | 413.267 | 451.952 | .976 | .077 |
| AVG* | 2.017 | 10.736 | 6.500 | 21.785 | 251.125 | 223.360 | 532.663 | 407.051 | .966 | .078 |

TCAS ON WITH AND WITHOUT INTERFERENCE LIMITING

*AVG - Full Scan Average

TABLE B-18

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 386, % ATCRBS 75, % DABS 25 (% TCAS 25), LOS ANGELES

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 6.500 | 19.641 | 13.812 | 38.350 | 187.875 | 210.058 | 348.375 | 384.106 | .981 | .056 |
| II | .527 | 3.206 | .000 | .000 | 236.353 | 211.536 | 428.327 | 242.088 | .970 | .066 |
| III | .000 | .000 | .000 | .000 | 168.187 | 151.681 | 521.625 | 360.217 | .970 | .063 |
| IV | .000 | .000 | .000 | .000 | 223.807 | 231.294 | 259.705 | 374.583 | .978 | .075 |
| AVG* | 2.017 | 10.736 | 3.810 | 20.762 | 218.794 | 214.065 | 375.147 | 332.159 | .975 | .066 |
| | | | | | TCAS OFF | | | | | |
| I | 6.500 | 19.641 | 17.875 | 41.829 | 231.187 | 216.332 | 467.812 | 434.207 | .975 | .062 |
| II | .527 | 3.206 | 5.270 | 9.910 | 295.638 | 222.816 | 605.284 | 295.275 | .960 | .079 |
| III | .000 | .000 | 4.333 | 3.599 | 207.187 | 156.404 | 667.062 | 416.048 | .970 | .063 |
| IV | .000 | .000 | 6.158 | 11.357 | 267.017 | 242.608 | 360.528 | 411.992 | .976 | .077 |
| AVG* | 2.017 | 10.736 | 3.966 | 23.939 | 269.312 | 224.410 | 518.012 | 385.092 | .968 | .074 |
| | | | | | TCAS ON WITH INTERFERENCE LIMITING | | | | | |
| I | 6.500 | 19.641 | 23.562 | 42.637 | 259.000 | 216.721 | 747.937 | 586.038 | .960 | .076 |
| II | .527 | 3.206 | 5.797 | 11.131 | 319.612 | 224.670 | 902.715 | 400.613 | .949 | .085 |
| III | .000 | .000 | .000 | .000 | 234.812 | 157.422 | 1005.062 | 589.152 | .959 | .070 |
| IV | .000 | .000 | 3.079 | 7.305 | 285.631 | 248.354 | 575.693 | 552.290 | .974 | .078 |
| AVG* | 2.017 | 10.736 | 9.638 | 25.035 | 292.853 | 226.661 | 794.245 | 519.632 | .957 | .081 |
| | | | | | TCAS ON WITHOUT INTERFERENCE LIMITING | | | | | |

*AVG - Full Scan Average

TABLE B-19

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 386, % ATCRBS 46, % DABS 54 (% TCAS 25), LOS ANGELES

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 1.393 | 7.370 | 12.536 | 36.079 | 226.837 | 227.121 | 346.821 | 352.118 | .961 | .085 |
| II | .000 | .000 | 1.026 | 6.327 | 246.584 | 270.452 | 441.017 | 264.219 | .961 | .076 |
| III | 5.571 | 14.741 | .000 | .000 | 238.588 | 238.579 | 548.294 | 403.235 | .985 | .048 |
| IV | .000 | .000 | .000 | .000 | 258.375 | 273.534 | 235.625 | 387.232 | .987 | .052 |
| AVG * | .768 | 5.515 | 3.939 | 20.084 | 247.581 | 258.693 | 376.524 | 336.703 | .967 | .074 |
| | | | | | TCAS OFF | | | | | |
| I | .000 | .000 | 3.000 | 7.175 | 297.839 | 280.374 | 395.803 | 427.292 | .982 | .058 |
| II | .788 | 5.515 | 5.909 | 20.176 | 290.227 | 262.487 | 561.642 | 372.842 | .959 | .083 |
| III | 1.393 | 7.370 | 12.536 | 34.888 | 267.826 | 231.838 | 493.867 | 385.414 | .954 | .095 |
| IV | .000 | .000 | 4.105 | 10.296 | 289.439 | 273.296 | 657.898 | 284.987 | .953 | .082 |
| AVG * | 5.571 | 14.741 | .000 | .000 | 284.765 | 232.345 | 742.147 | 450.294 | .954 | .103 |
| | | | | TCAS ON WITH INTERFERENCE LIMITING | | | | | | |
| I | 1.393 | 7.370 | 17.411 | 36.516 | 304.439 | 234.797 | 1510.852 | 821.152 | .919 | .129 |
| II | .000 | .000 | 7.697 | 13.248 | 330.366 | 279.056 | 1865.537 | 626.696 | .904 | .121 |
| III | 5.571 | 14.741 | 5.571 | 9.515 | 339.529 | 252.942 | 2031.441 | 808.119 | .909 | .107 |
| IV | .000 | .000 | 4.590 | 10.031 | 338.696 | 285.690 | 1488.035 | 891.852 | .929 | .096 |
| AVG * | .788 | 5.515 | 9.652 | 22.351 | 331.605 | 268.030 | 1698.665 | 776.341 | .912 | .117 |
| | | | | TCAS ON WITHOUT INTERFERENCE LIMITING | | | | | | |

*AVG - Full Scan Average

TABLE B-20

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.04, TOTAL A/C 203, % ATCRBS 75, % DABS 25 (% TCAS 11), LOS ANGELES

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | 15.321 | 38.379 | 206.143 | 219.419 | 301.902 | 372.073 | .985 | .045 |
| II | 4.105 | 17.894 | .000 | .000 | 229.021 | 196.627 | 447.878 | 240.505 | .963 | .070 |
| III | .000 | .000 | .000 | .000 | 192.000 | 166.579 | 448.500 | 362.284 | .949 | .076 |
| IV | .000 | .000 | .000 | .000 | 221.159 | 236.329 | 228.768 | 360.197 | .984 | .047 |
| AVG* | 1.625 | 11.258 | 4.469 | 21.376 | 220.224 | 210.300 | 366.037 | 326.523 | .972 | .062 |

TCAS OFF

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | .000 | .000 | 18.107 | 37.831 | 218.679 | 223.628 | 326.973 | 388.244 | .985 | .045 |
| II | 4.105 | 17.894 | .000 | .000 | 248.521 | 199.517 | 474.431 | 251.988 | .959 | .072 |
| III | .000 | .000 | .000 | .000 | 205.500 | 169.739 | 492.000 | 385.210 | .949 | .076 |
| IV | .000 | .000 | 1.625 | 5.629 | 235.902 | 234.195 | 265.866 | 374.119 | .984 | .047 |
| AVG* | 1.625 | 11.258 | 5.687 | 21.646 | 236.619 | 212.690 | 395.433 | 339.753 | .970 | .063 |

TCAS ON WITH AND WITHOUT INTERFERENCE LIMITING

*AVG - Full Scan Average

TABLE B-21

RESULTS AND STATISTICS FOR UPLINK QUANTITIES COMPUTED AT EACH TRANSPONDER AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.02, TOTAL A/C 92, % ATCRBS 75, % DABS 25 (% TCAS 11), LOS ANGELES

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 6.500 | 15.922 | 3.250 | 7.961 | 206.839 | 155.760 | 282.054 | 368.747 | .958 | .069 |
| II | 9.750 | 27.577 | .000 | .000 | 243.500 | 217.367 | 445.500 | 215.410 | .961 | .068 |
| III | .000 | .000 | .000 | .000 | 166.833 | 153.578 | 424.667 | 359.929 | .956 | .074 |
| IV | .000 | .000 | .000 | .000 | 261.083 | 269.631 | 149.500 | 292.615 | .988 | .042 |
| AVG* | 5.850 | 19.085 | .975 | 4.360 | 229.337 | 208.291 | 341.250 | 315.430 | .964 | .065 |

TCAS OFF

| QUAD | ALL-CALL RATE | ALL-CALL RATE STD.DEV. | ROLL-CALL RATE | ROLL-CALL RATE STD.DEV. | ATCRBS RATE | ATCRBS RATE STD.DEV. | EFF.SUPP. RATE | EFF.SUPP. RATE STD.DEV. | PROB. OF REPLY | PROB. OF REPLY STD.DEV. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 6.500 | 15.922 | 3.250 | 7.961 | 212.411 | 157.200 | 282.750 | 368.311 | .958 | .069 |
| II | 9.750 | 27.577 | .000 | .000 | 258.500 | 227.307 | 446.500 | 215.207 | .961 | .068 |
| III | .000 | .000 | .000 | .000 | 173.333 | 157.650 | 424.667 | 360.236 | .956 | .074 |
| IV | .000 | .000 | .000 | .000 | 265.417 | 269.382 | 149.500 | 292.639 | .988 | .042 |
| AVG* | 5.850 | 19.085 | .975 | 4.360 | 238.663 | 213.365 | 341.886 | 315.354 | .964 | .065 |

TCAS ON WITH AND WITHOUT INTERFERENCE LIMITING

*AVG - Full Scan Average

TABLE B-22

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LOS ANGELES DABS SENSOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.159, TOTAL A/C 743, % ATCRBS 75, % DABS 25 (% TCAS 11)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | |
|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off |
| I | 11 | 16 | 30 | 1820 | 2092 | 2386 |
| II | 0 | 12 | 31 | 3429 | 3419 | 4309 |
| III | 0 | 8 | 8 | 346 | 404 | 468 |
| IV | 0 | 8 | 19 | 1906 | 2179 | 2359 |

TABLE B-23

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LOS ANGELES DABS SENSOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.159, TOTAL A/C 743, % ATCRBS 75, % DABS 25 (% TCAS 25)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | |
|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off |
| I | 11 | 23 | 57 | 1820 | 2267 | 2938 |
| II | 0 | 18 | 78 | 3429 | 4252 | 5472 |
| III | 0 | 5 | 13 | 346 | 415 | 561 |
| IV | 0 | 11 | 23 | 1906 | 2310 | 2665 |

TABLE B-24

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LOS ANGELES DABS SENSOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 386, % ATCRBS 75, % DABS 25 (% TCAS 11)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | |
|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off |
| I | 7 | 12 | 12 | 810 | 982 | 982 |
| II | 0 | 3 | 3 | 1821 | 1989 | 1989 |
| III | 0 | 2 | 2 | 250 | 198 | 198 |
| IV | 0 | 2 | 2 | 784 | 1001 | 1001 |

TABLE B-25

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LOS ANGELES DABS SENSOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 386, % ATCRBS 75, % DABS 25 (% TCAS 25)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | |
|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off |
| I | 7 | 10 | 20 | 810 | 1051 | 1166 |
| II | 1 | 8 | 10 | 1821 | 2195 | 2325 |
| III | 0 | 2 | 0 | 250 | 208 | 232 |
| IV | 0 | 3 | 3 | 784 | 1036 | 1089 |

TABLE B-26

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LOS ANGELES DABS SENSOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.08, TOTAL A/C 386, % ATCRBS 46, % DABS 54 (% TCAS 25)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | |
|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off | TCAS OFF | TCAS ON Interference Limiting On | TCAS ON Interference Limiting Off |
| I | 11 | 16 | 29 | 949 | 1096 | 1207 |
| II | 0 | 16 | 32 | 1796 | 2091 | 2281 |
| III | 0 | 3 | 5 | 166 | 197 | 230 |
| IV | 0 | 8 | 23 | 980 | 1123 | 1230 |

TABLE B-27

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LOS ANGELES DABS SENSOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.04, TOTAL A/C 201, % ATCRBS 75, % DABS 25 (% TCAS 11)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | |
|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off |
| I | 6 | 8 | 8 | 505 | 535 | 535 |
| II | 0 | 0 | 0 | 926 | 999 | 999 |
| III | 0 | 0 | 0 | 97 | 109 | 109 |
| IV | 0 | 1 | 1 | 390 | 410 | 410 |

TABLE B-28

RESULTS AND STATISTICS FOR DOWNLINK QUANTITIES COMPUTED AT THE LOS ANGELES DABS SENSOR AND AVERAGED OVER THE QUADRANT FOR A/C DENSITY 0.02, TOTAL A/C 92, % ATCRBS 75, % DABS 25 (% TCAS 11)

| QUADRANT | DABS ROLL-CALL FRUIT RATE (/s) | | | ATCRBS FRUIT RATE (/s) | | |
|---|---|---|---|---|---|---|
| | TCAS OFF | TCAS ON Interference Limiting | | TCAS OFF | TCAS ON Interference Limiting | |
| | | On | Off | | On | Off |
| I | 1 | 1 | 1 | 246 | 252 | 252 |
| II | 0 | 0 | 0 | 397 | 423 | 423 |
| III | 0 | 0 | 0 | 56 | 56 | 56 |
| IV | 0 | 0 | 0 | 204 | 205 | 205 |

Figures B-1 through B-8 graphically present the reply performance of transponders corresponding to the 0.159 and the 0.08 aircraft density simulations with both the 25% DABS (11% TCAS) distribution and the 25% DABS (25% TCAS) distribution. Included is the position of the aircraft with the lowest probability of reply for each simulation.[a] Note that the Long Beach ATCRBS interrogator transmits an average of 21.28 interrogations to each aircraft during the mainbeam dwell; some aircraft received 21 interrogations and some received 22. Similarly, the Los Angeles DABS sensor transmits an average of 6.56 ATCRBS-Only interrogations to each aircraft during the mainbeam dwell; some aircraft received 6 interrogations and some received 7.

Figures B-9 through B-12 give the cumulative distributions of the ATCRBS interrogation rate and the effective suppresion rate for transponders in the 0.159 aircraft density environment for the 25% DABS (11% TCAS) distribution.

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[a]Aircraft positions are given in radians; multiply by 57.296 to find the position in degrees.

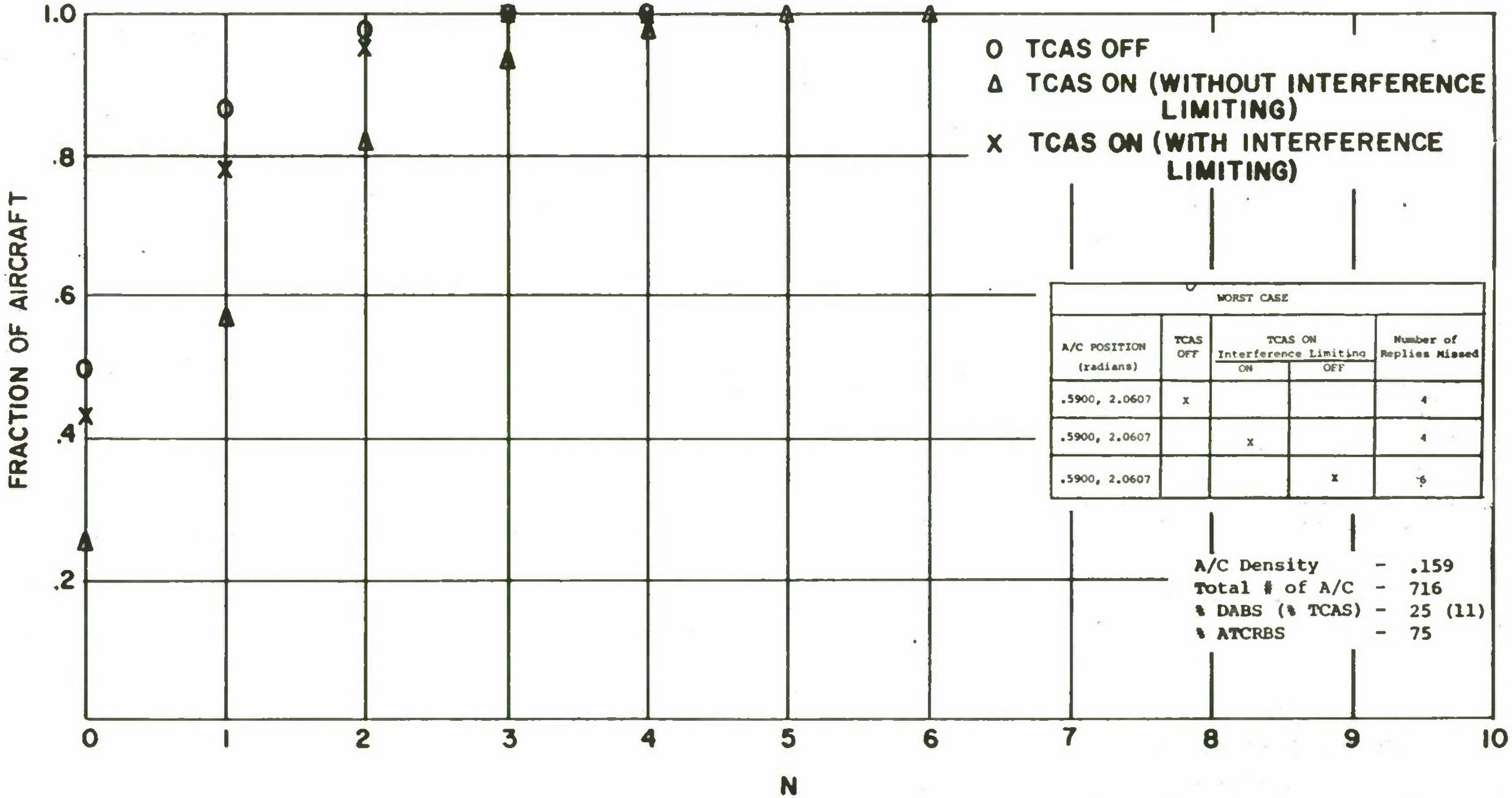



Figure B-1. Cumulative distribution for the number of missed interrogations (N) out of a possible 21 or 22 per mainbeam dwell for the Long Beach ATCRBS interrogator.

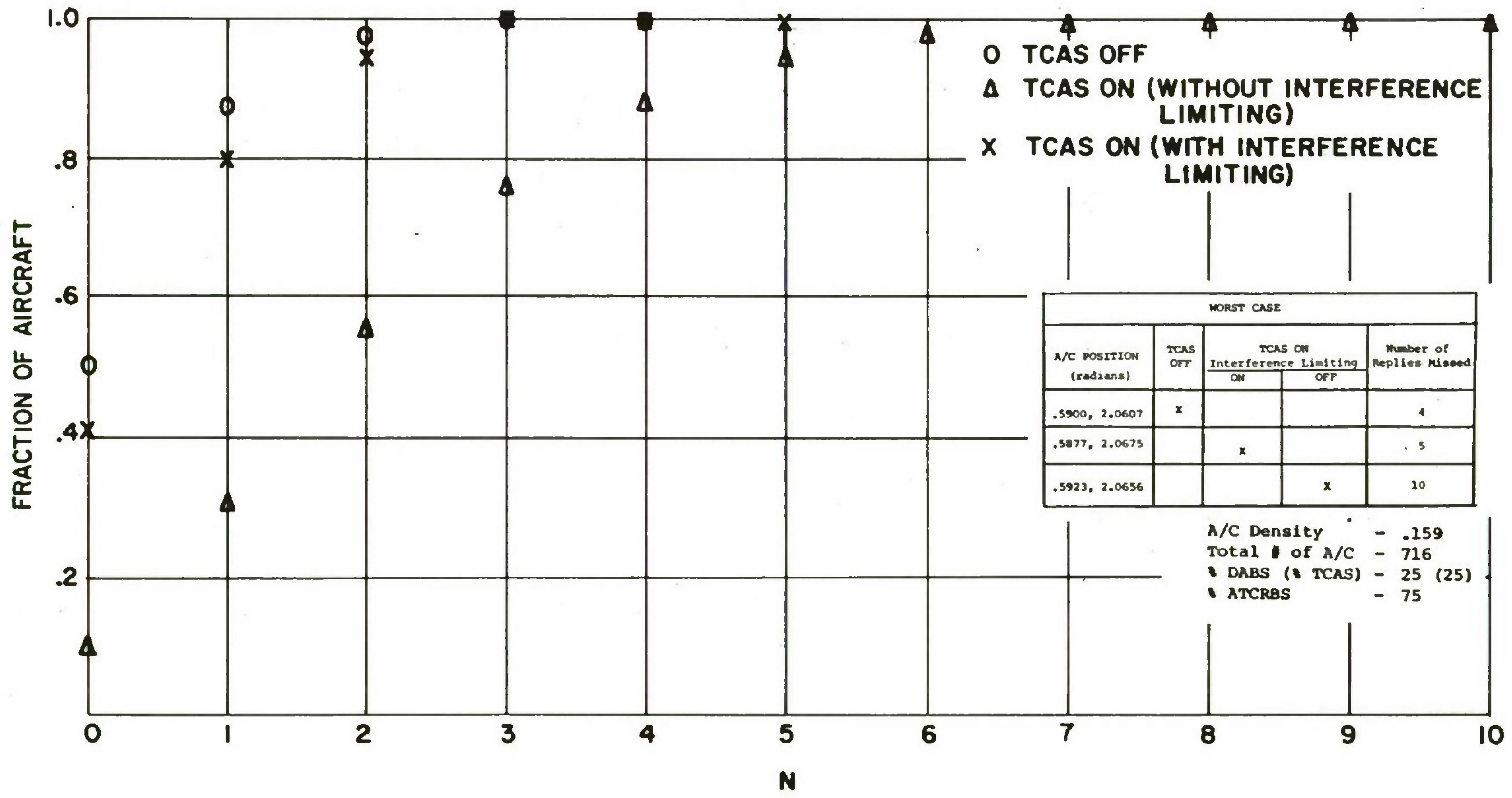



Figure B-2. Cumulative distribution for the number of missed interrogations (N) out of a possible 21 or 22 per mainbeam dwell for the Long Beach ATCRBS interrogator.

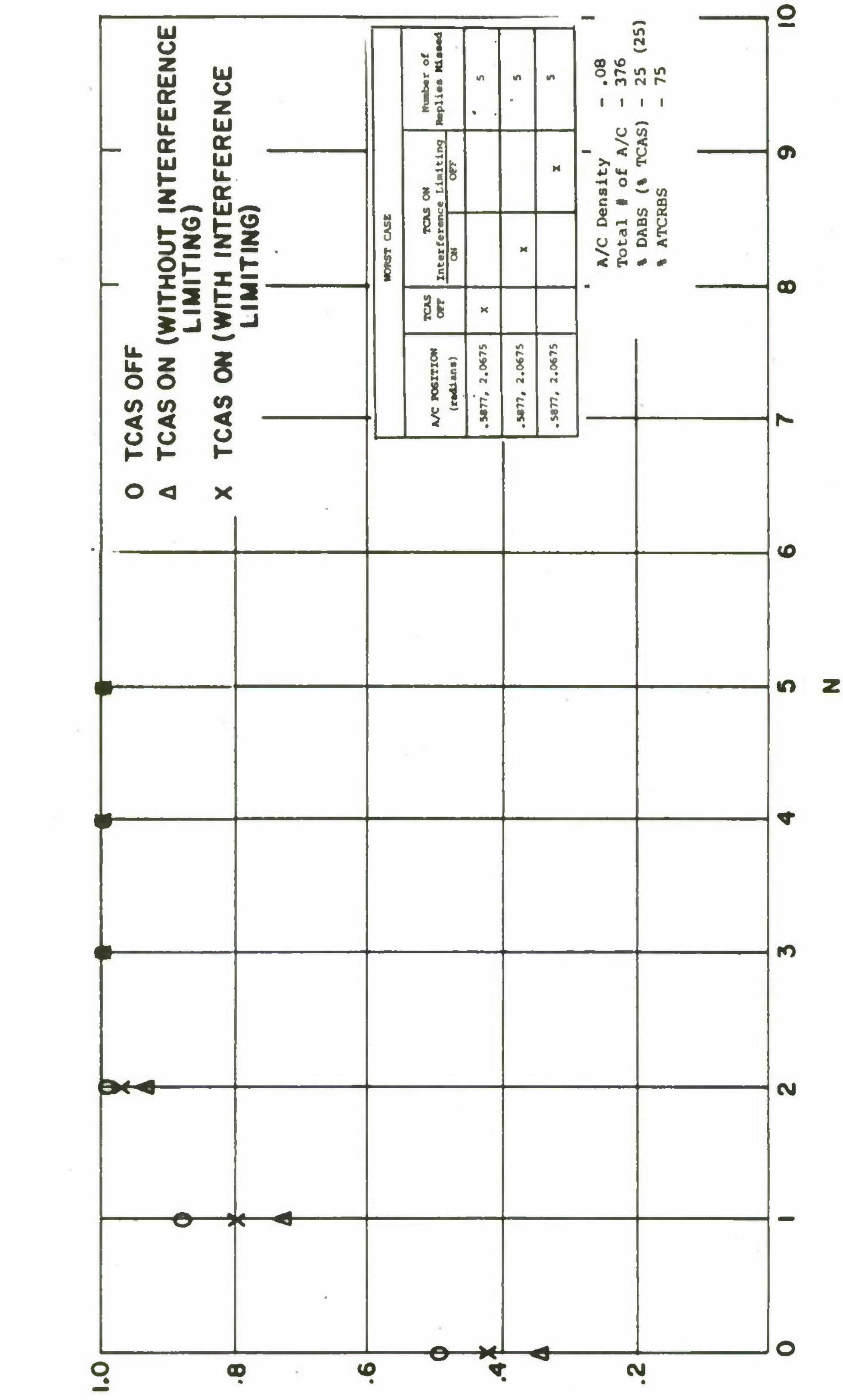
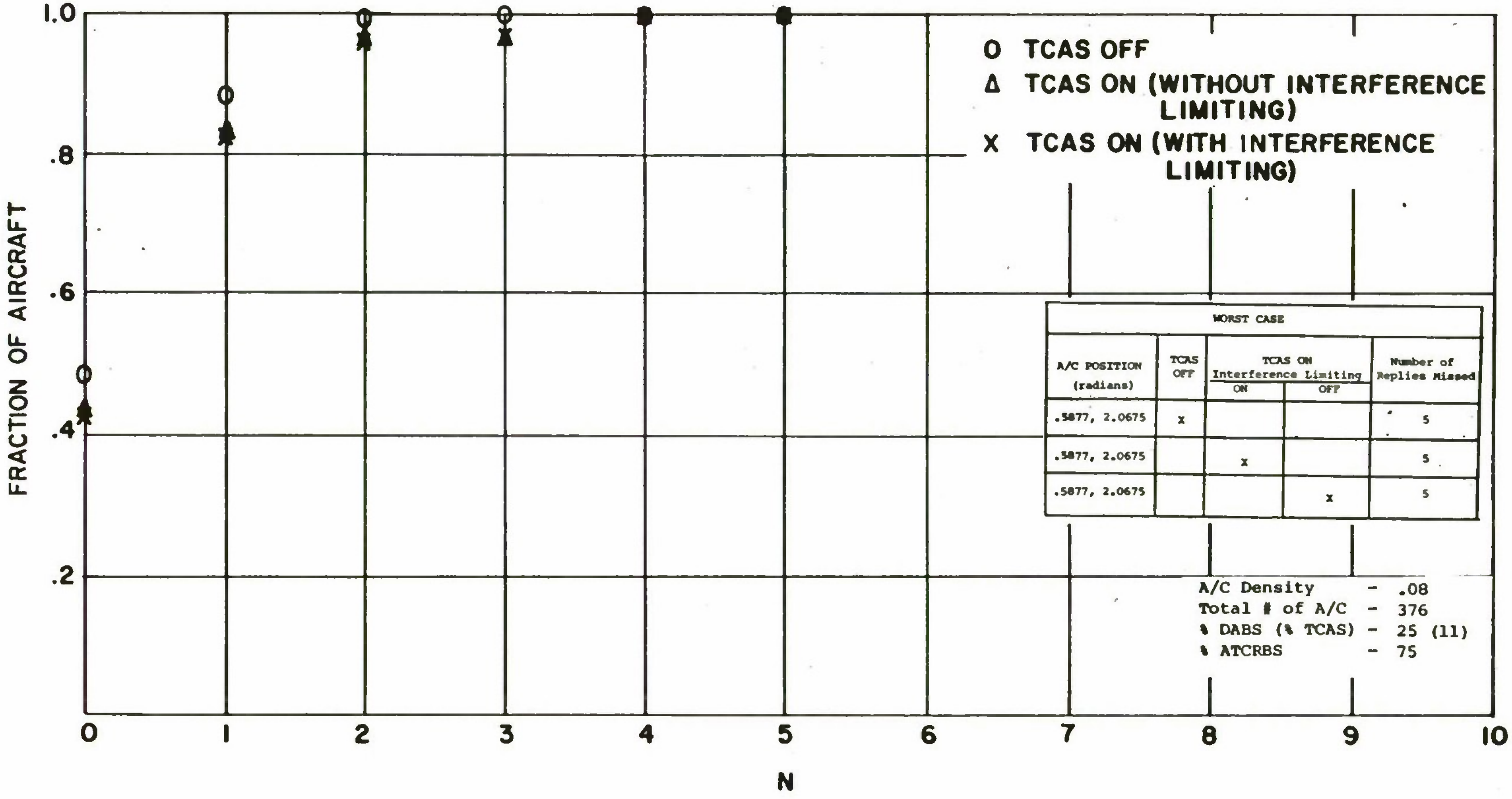
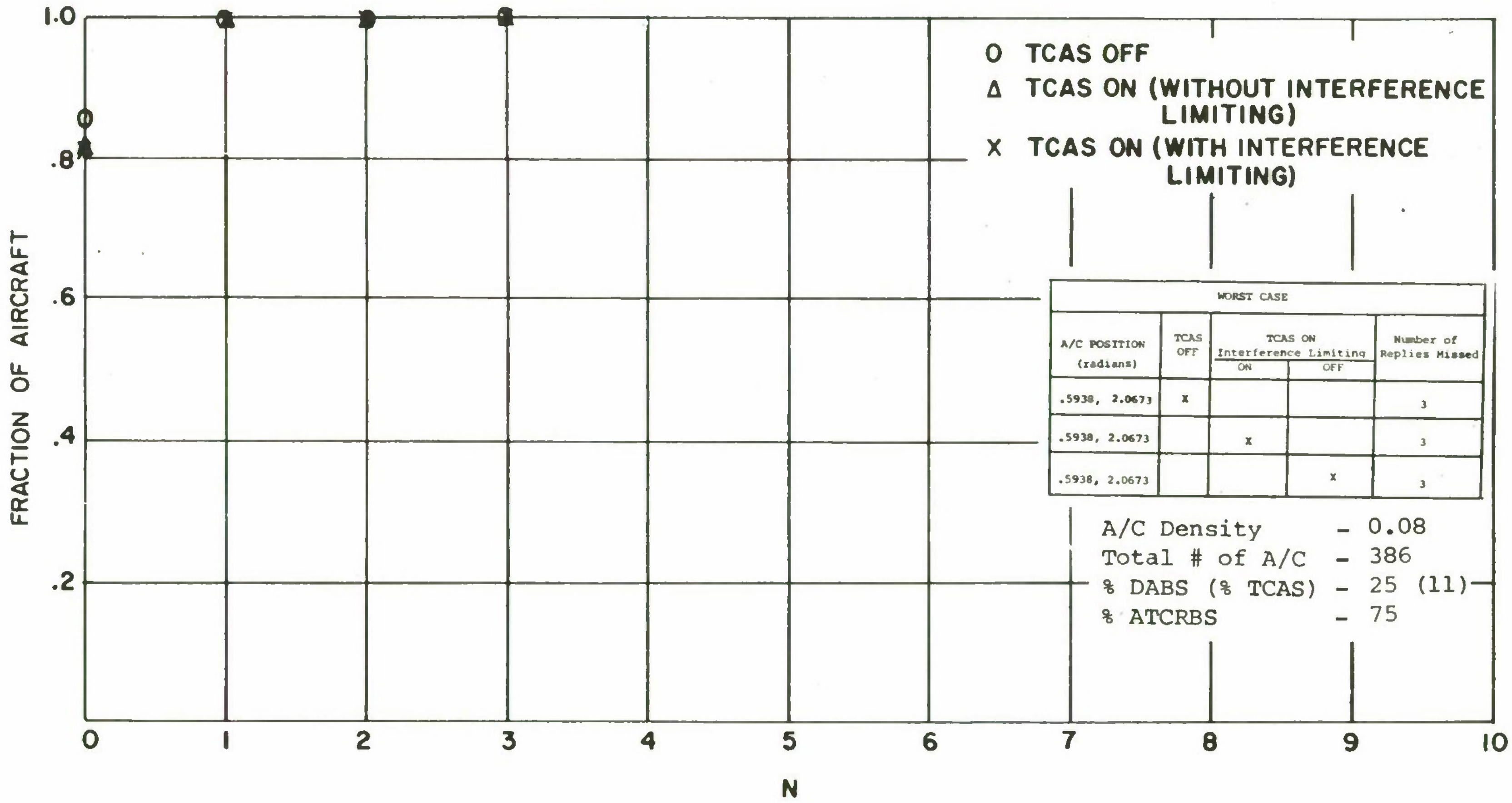



Figure B-3. Cumulative distribution for the number of missed interrogations (N) out of a possible 21 or 22 per mainbeam dwell for the Long Beach ATCRBS interrogator.



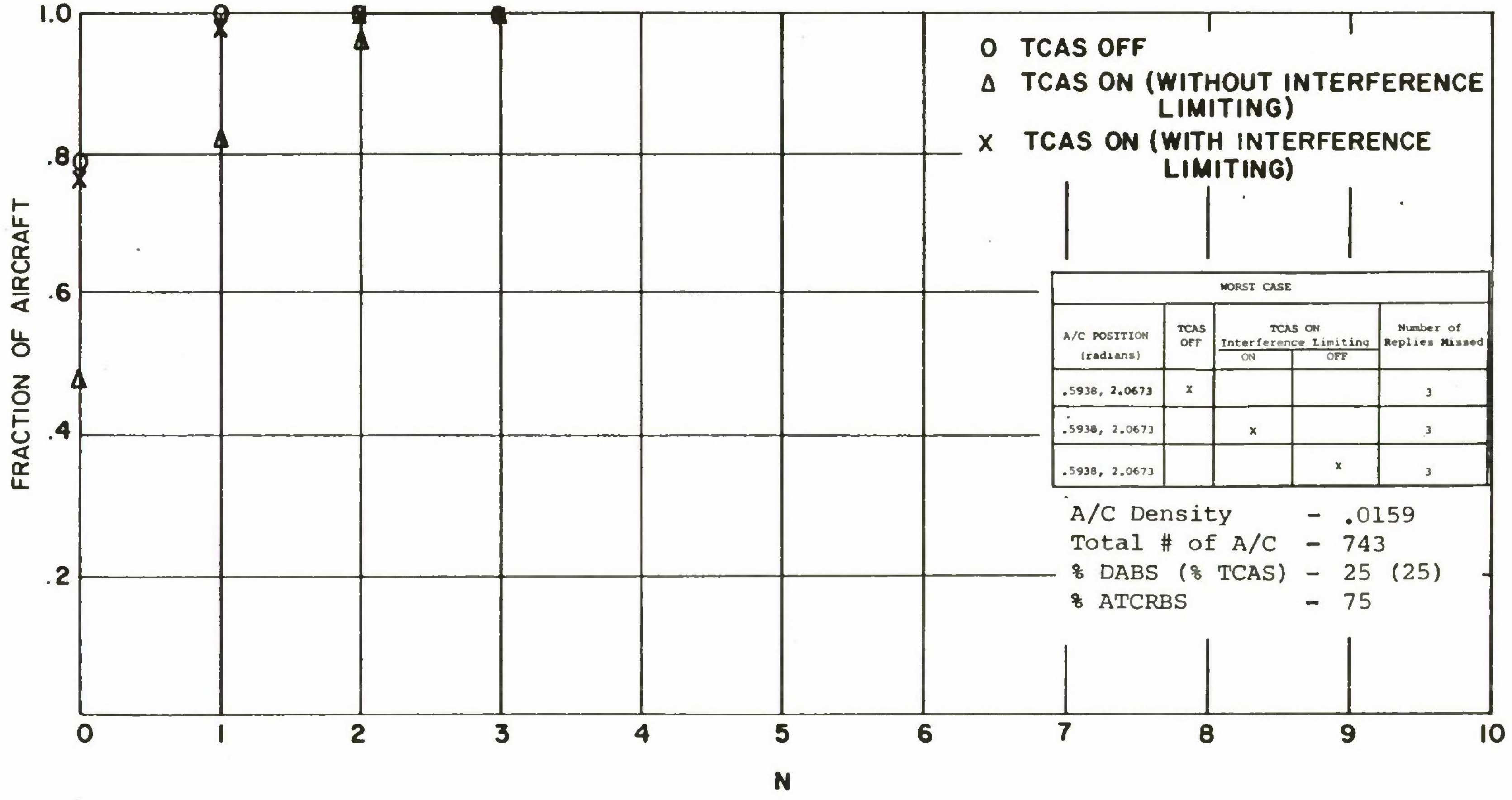

| WORST CASE | | | | |
|---|---|---|---|---|
| A/C POSITION (radians) | TCAS OFF | TCAS ON Interference Limiting ON | TCAS ON Interference Limiting OFF | Number of Replies Missed |
| .5877, 2.0675 | x | | | 5 |
| .5877, 2.0675 | | x | | 5 |
| .5877, 2.0675 | | | x | 5 |

Figure B-4. Cumulative distribution for the number of missed interrogations (N) out of a possible 21 or 22 per mainbeam dwell for the Long Beach ATCRBS interrogator.



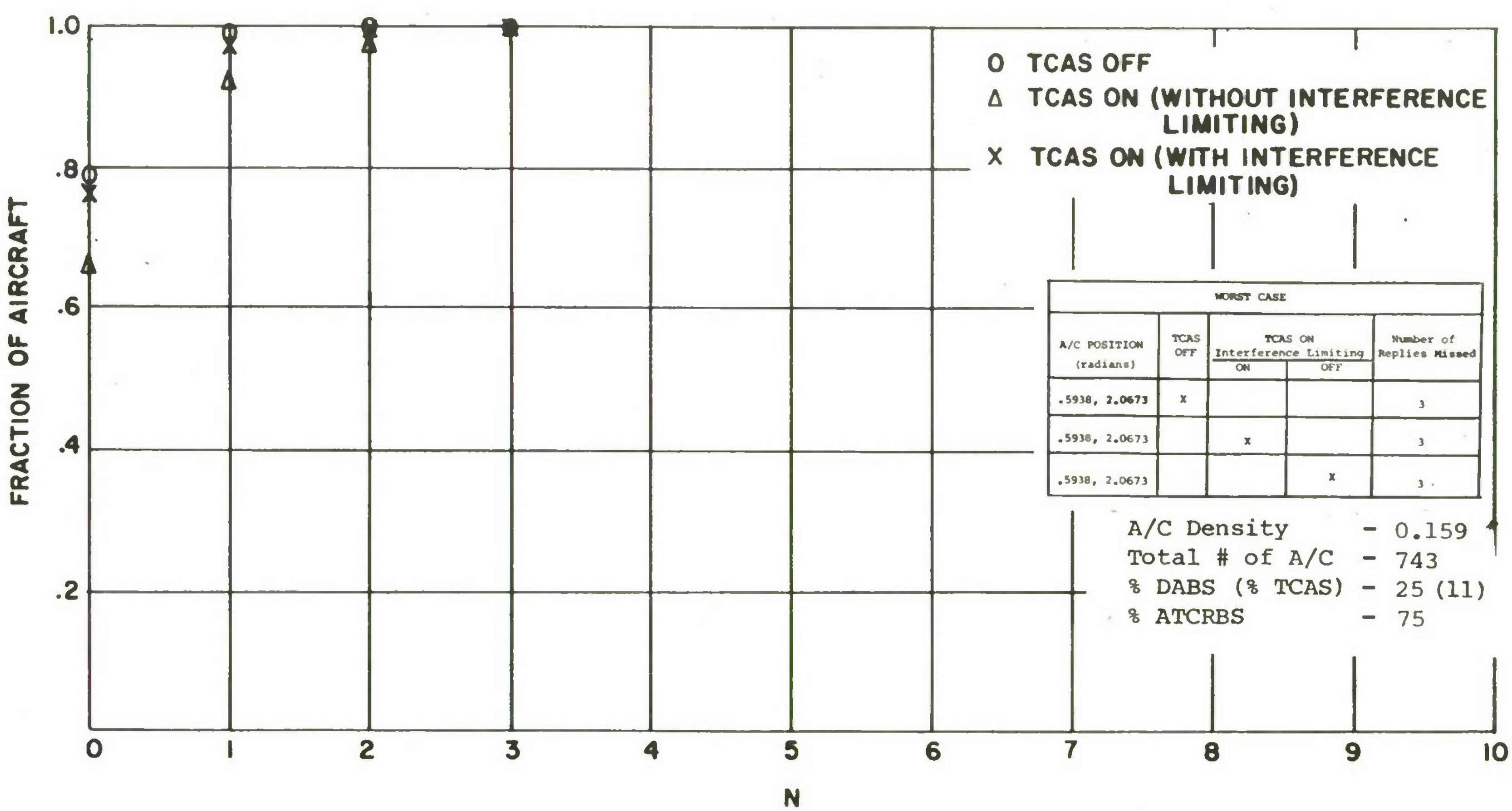

| WORST CASE | | | | |
|---|---|---|---|---|
| A/C POSITION (radians) | TCAS OFF | TCAS ON Interference Limiting ON | TCAS ON Interference Limiting OFF | Number of Replies Missed |
| .5938, 2.0673 | x | | | 3 |
| .5938, 2.0673 | | x | | 3 |
| .5938, 2.0673 | | | x | 3 |

Figure B-5. Cumulative distribution for the number of missed interrogations (N) out of a possible 6 or 7 per mainbeam dwell for the Los Angeles DABS sensor. (ATCRBS transponders only)



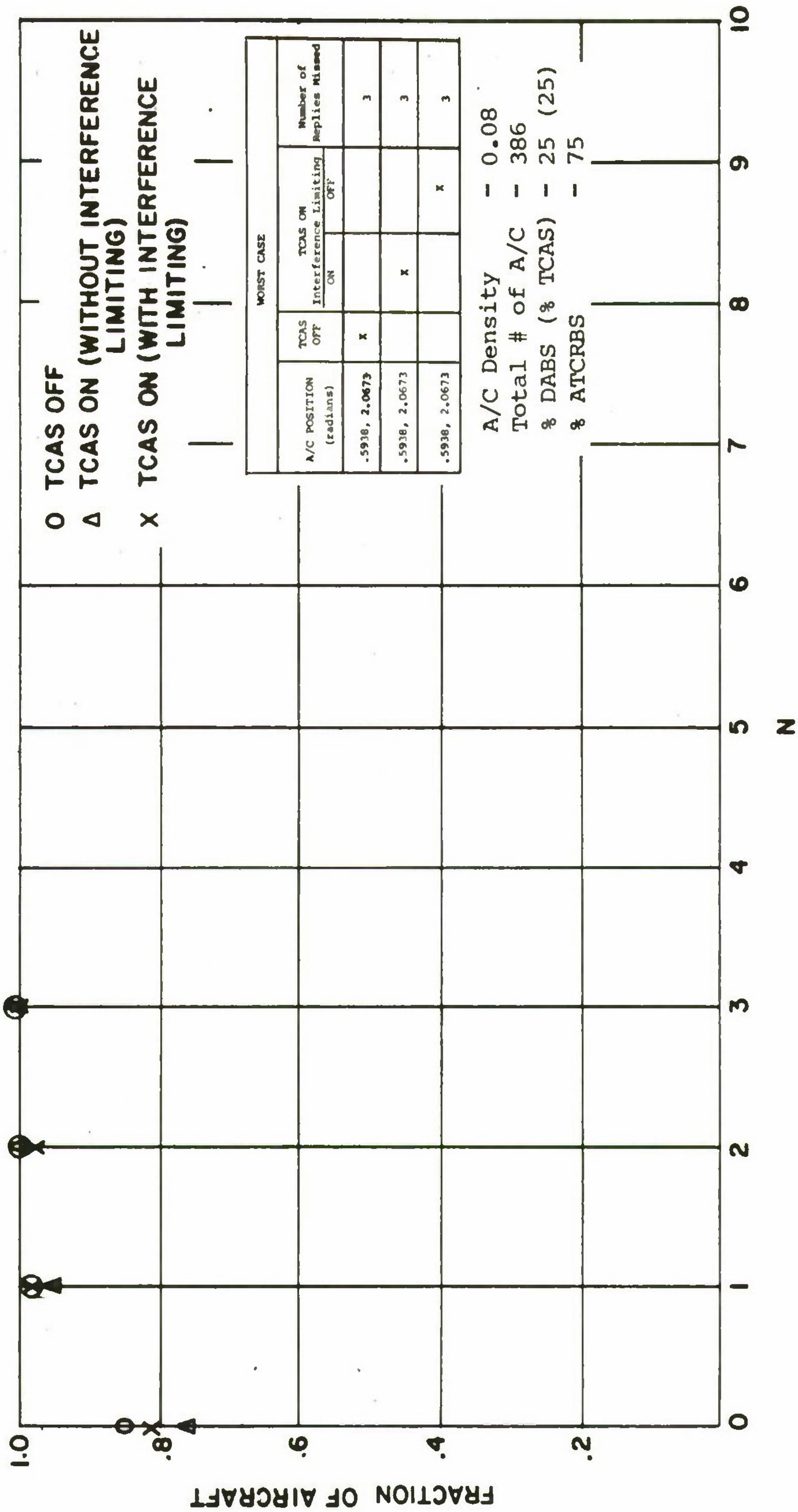

| WORST CASE | | | | |
|---|---|---|---|---|
| A/C POSITION (radians) | TCAS OFF | TCAS ON Interference Limiting ON | TCAS ON Interference Limiting OFF | Number of Replies Missed |
| .5938, 2.0673 | x | | | 3 |
| .5938, 2.0673 | | x | | 3 |
| .5938, 2.0673 | | | x | 3 |

Figure B-6. Cumulative distribution for the number of missed interrogations (N) out of a possible 6 or 7 per mainbeam dwell for the Los Angeles DABS sensor. (ATCRBS transponders only)




| WORST CASE | | | | |
|---|---|---|---|---|
| A/C POSITION (radians) | TCAS OFF | TCAS ON Interference Limiting ON | TCAS ON Interference Limiting OFF | Number of Replies Missed |
| .5938, 2.0673 | X | | | 3 |
| .5938, 2.0673 | | X | | 3 |
| .5938, 2.0673 | | | X | 3 |

Figure B-7. Cumulative distribution for the number of missed interrogations (N) out of a possible 6 or 7 per mainbeam dwell for the Los Angeles DABS sensor. (ATCRBS transponders only)




| WORST CASE | | | | |
|---|---|---|---|---|
| A/C POSITION (radians) | TCAS OFF | TCAS ON Interference Limiting ON | TCAS ON Interference Limiting OFF | Number of Replies Missed |
| .5938, 2.0673 | x | | | 3 |
| .5938, 2.0673 | | x | | 3 |
| .5938, 2.0673 | | | x | 3 |

Figure B-8. Cumulative distribution for the number of missed interrogations (N) out of a possible 6 or 7 per mainbeam dwell for the Los Angeles DABS sensor. (ATCRBS transponders only)

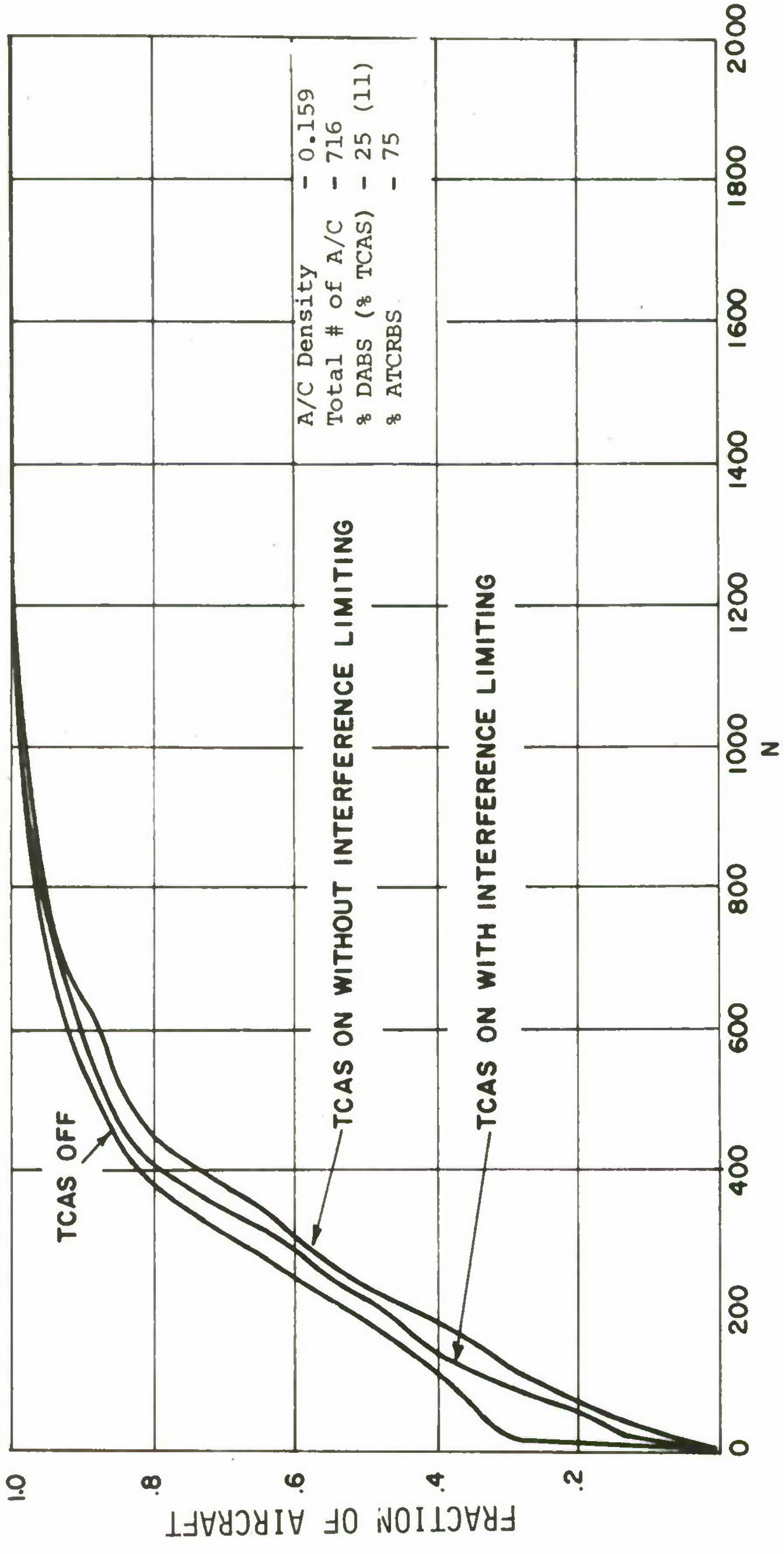



Figure B-9. Cumulative distribution for the total number of ATCRBS interrogations per second (N) received at the transponders. Long Beach simulations - no DABS sensors in the environment.

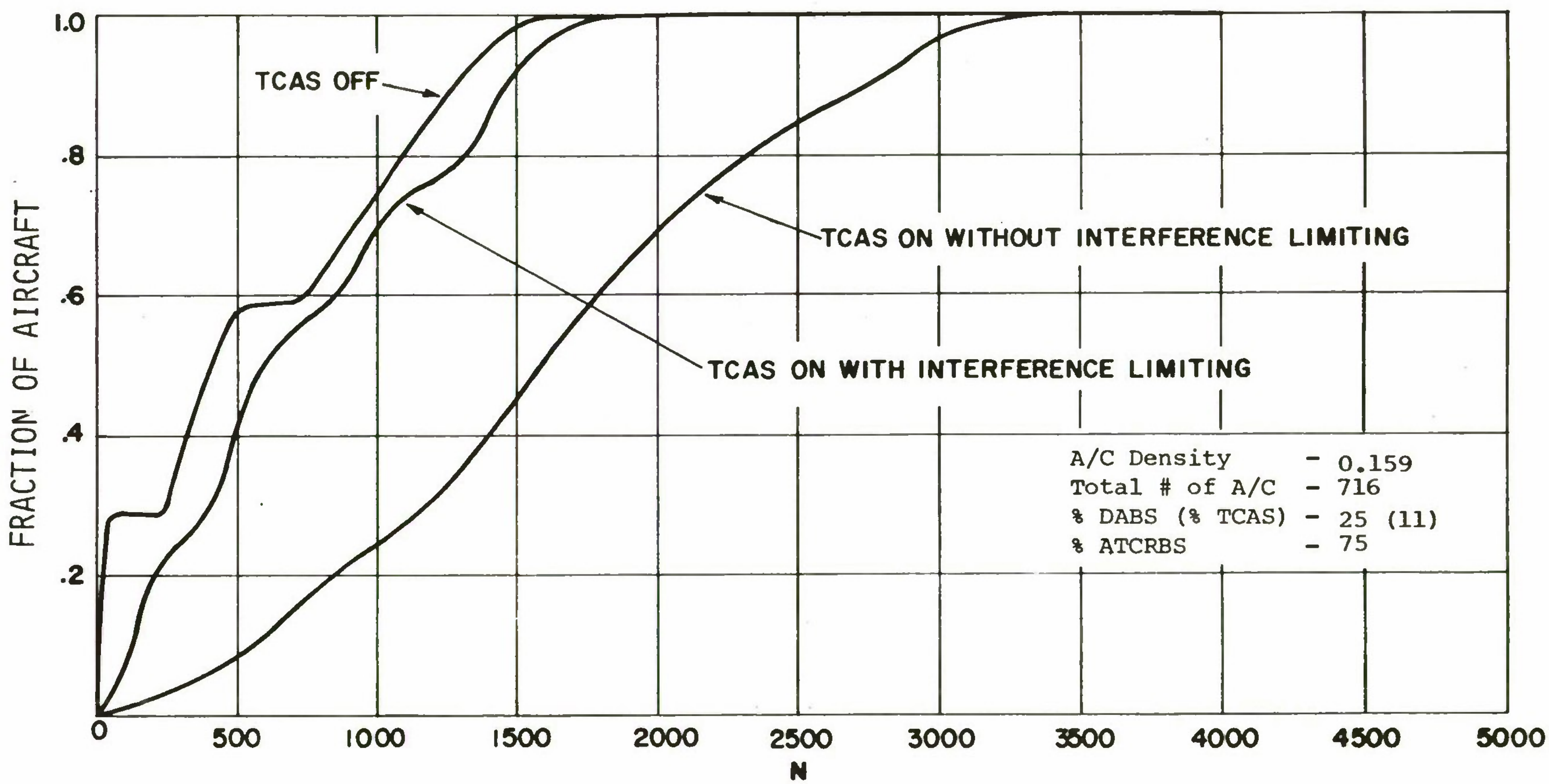



Figure B-10. Cumulative distribution for the total number of effective suppressions per second (N) received at the transponders. Long Beach simulations - no DABS sensors in the environment.

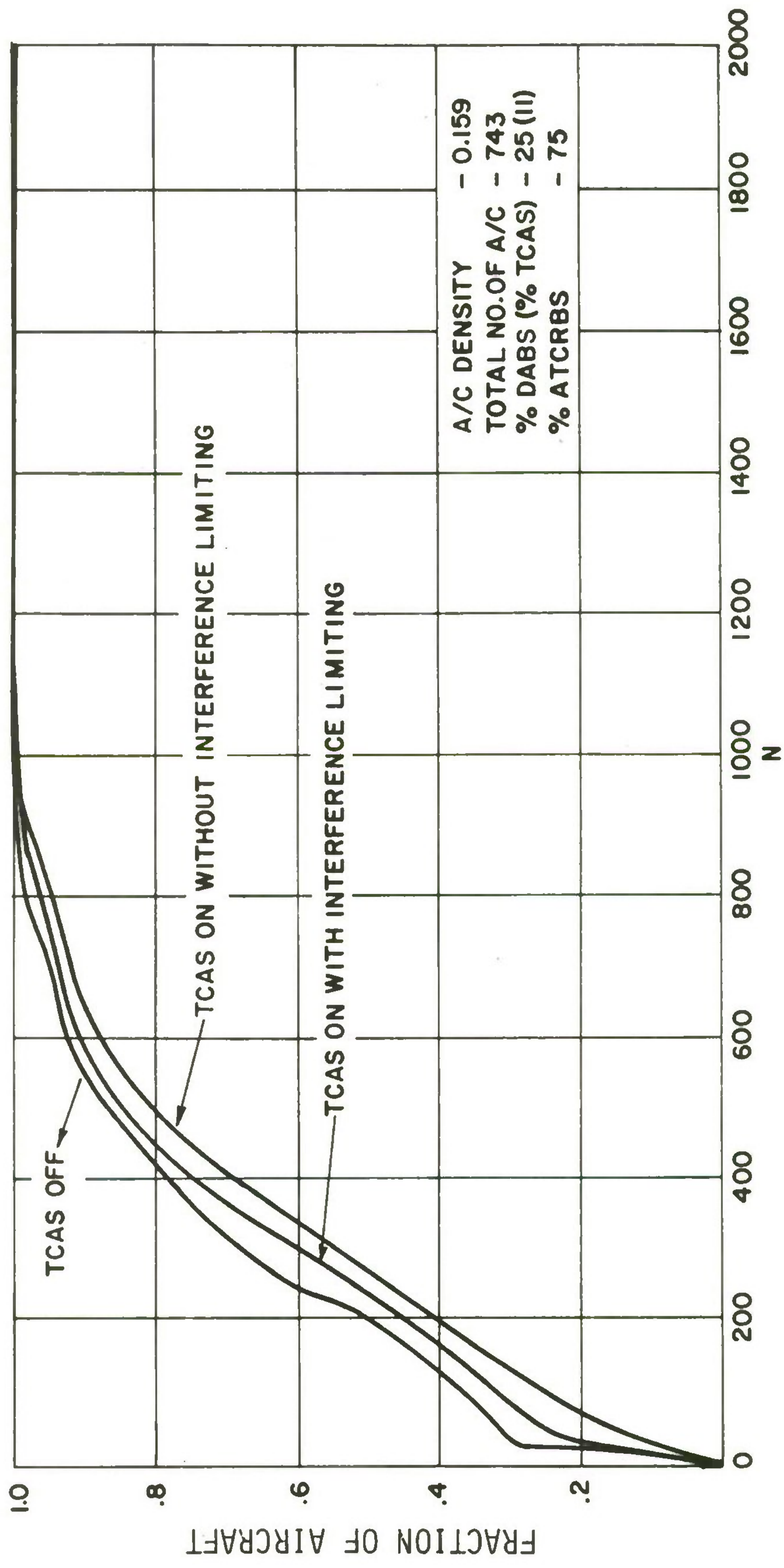



Figure B-11. Cumulative distribution for the total number of ATCRBS interrogations per second (N) received at the transponders. Los Angeles simulations.

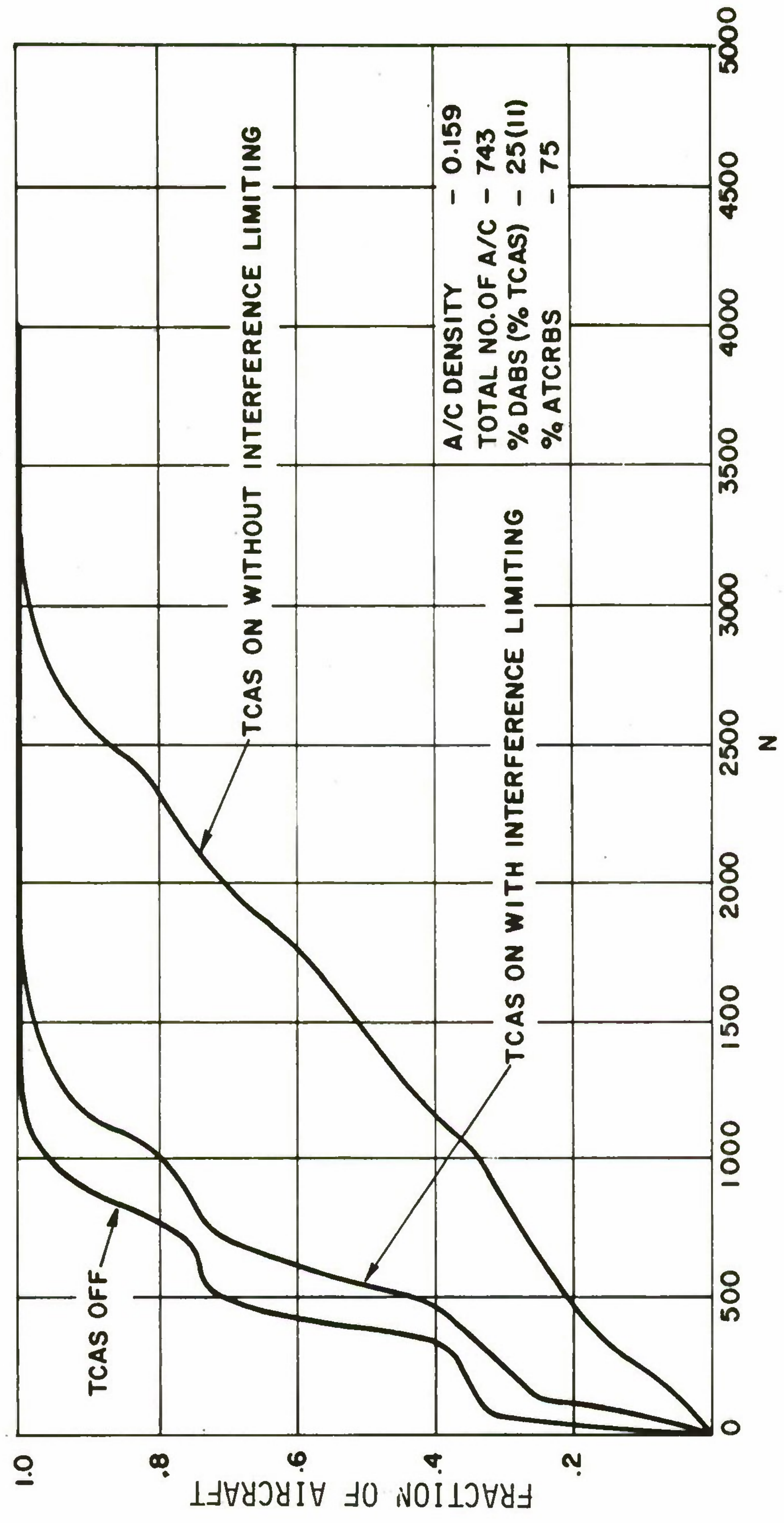



Figure B-12. Cumulative distribution for the total number of effective suppressions per second (N) received at the transponders. Los Angeles simulations.

# APPENDIX C

## TCAS SUBMODEL RESULTS

The following tables (C-1 through C-11) give TCAS submodel results for each of the simulations conducted in this analysis. Given are: 1) TCAS aircraft position, 2) the density of aircraft within 30 nmi about the TCAS-equipped aircraft, 3) the rate at which the TCAS-equipped aircraft transmits discretely addressed interrogations, and 4) the transmission power (at transmitter) of the TCAS-equipped aircraft. Also included are figures (C-1 through C-4) illustrating the locations of the TCAS-equipped aircraft that experienced interference-limiting.

The information in the tables is presented for the configurations shown in the following matrix:

| CONDITION | TABLE NO. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| With TCAS Interference-Limiting Function | X | - | X | - | X | X | - | X | - | X | X |
| Without TCAS Interference-Limiting Function | - | X | - | X | X | - | X | - | X | X | X |
| A/C per sq. nmi (within 30 nmi of LAX-4 | 0.159 | 0.159 | 0.159 | 0.159 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.04 | 0.02 |
| % A/C ATCRBS-equipped | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 46 | 46 | 75 | 75 |
| % A/C DABS-equipped (% TCAS-equipped) | 25 (11) | 25 (11) | 25 (25) | 25 (25) | 25 (11) | 25 (25) | 25 (25) | 54 (25) | 54 (25) | 25 (11) | 25 (11) |

The legend given below is to be used in conjunction with Tables C-1 through C-11.

| | |
|---|---|
| LAT | - Latitude in radians |
| LON | - Longitude in radians |
| ALT | - Altitude in feet |
| LOCAL DENSITY | - Density of A/C within 30 nmi of TCAS |
| INT RATE | - DABS interrogations per second transmitted by the TCAS unit |
| PWR | - TCAS transmission power at transmitter (watts) |

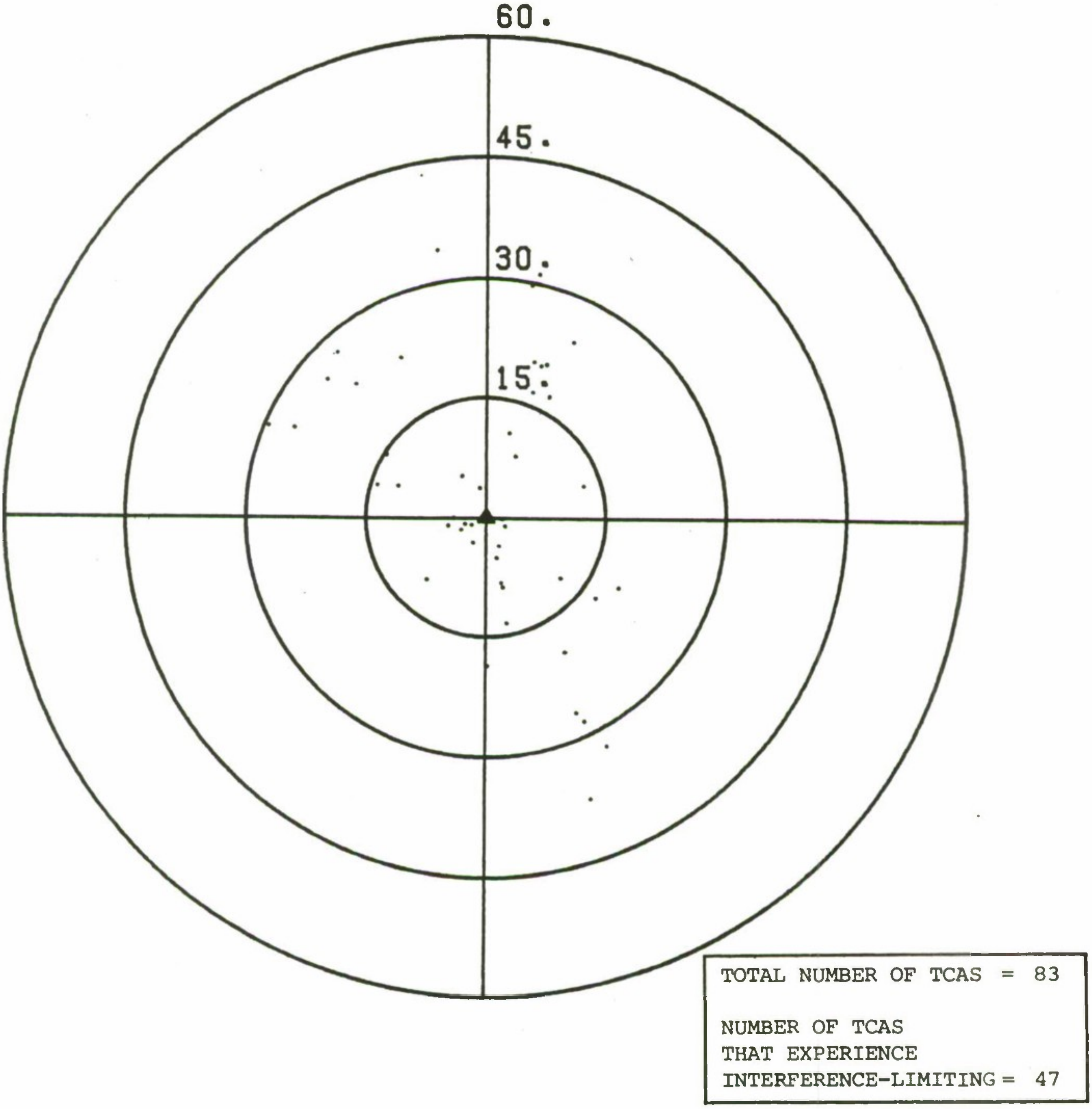
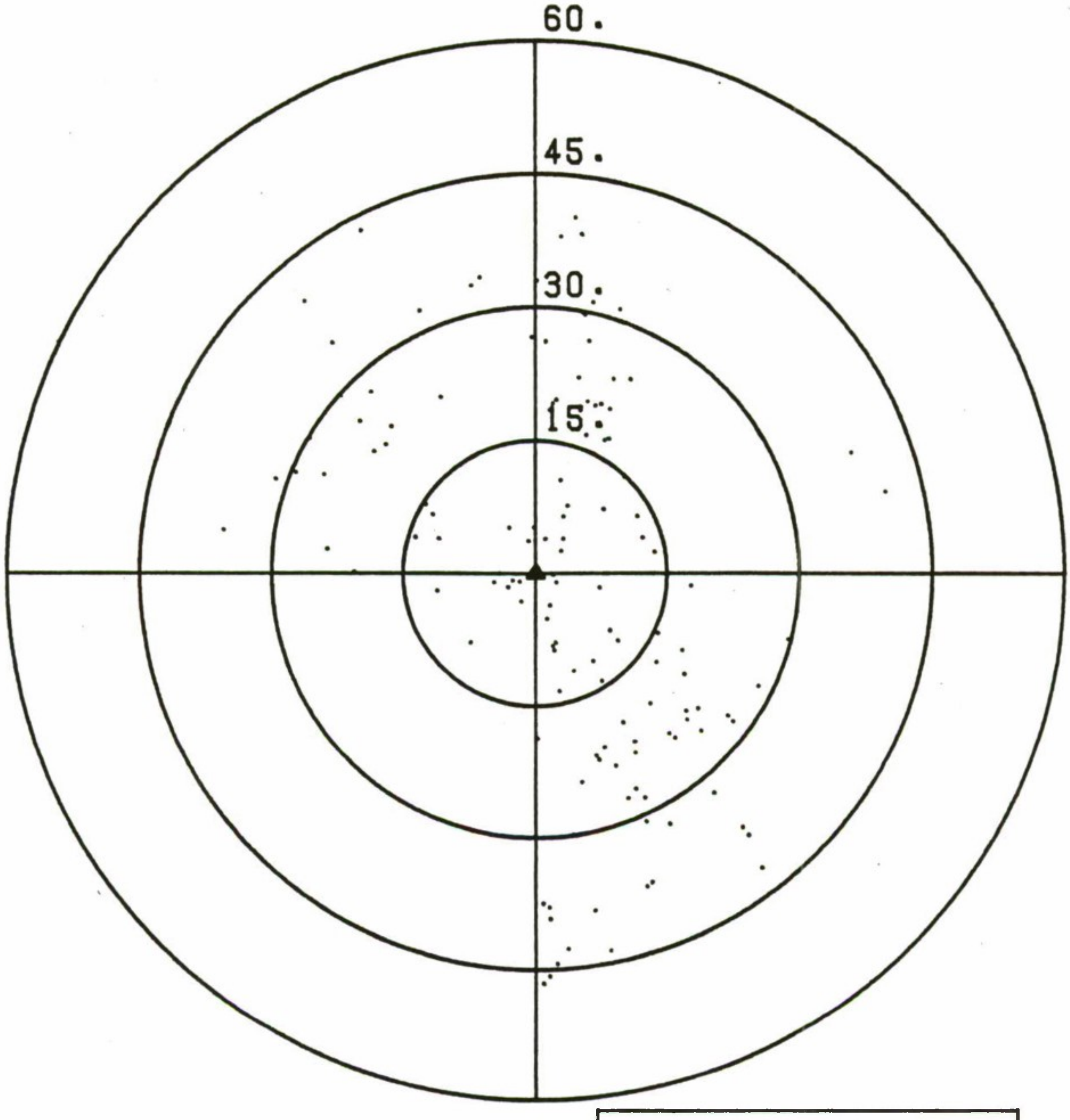
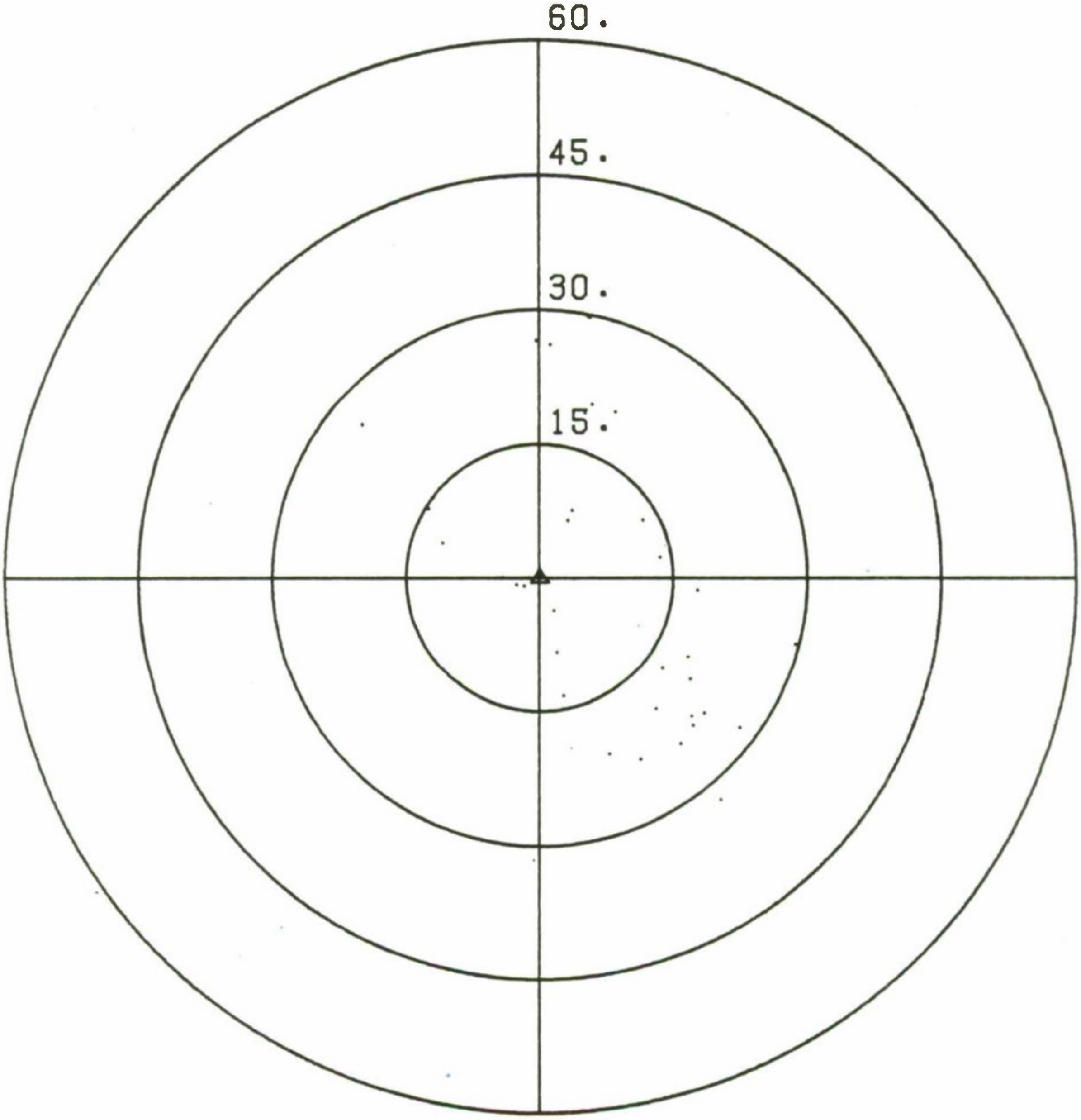



Figure C-1. Location of TCAS-equipped aircraft that experienced interference-limiting; Density = 0.159 A/C per square nmi, 25% DABS (11% TCAS). See TABLE C-1.



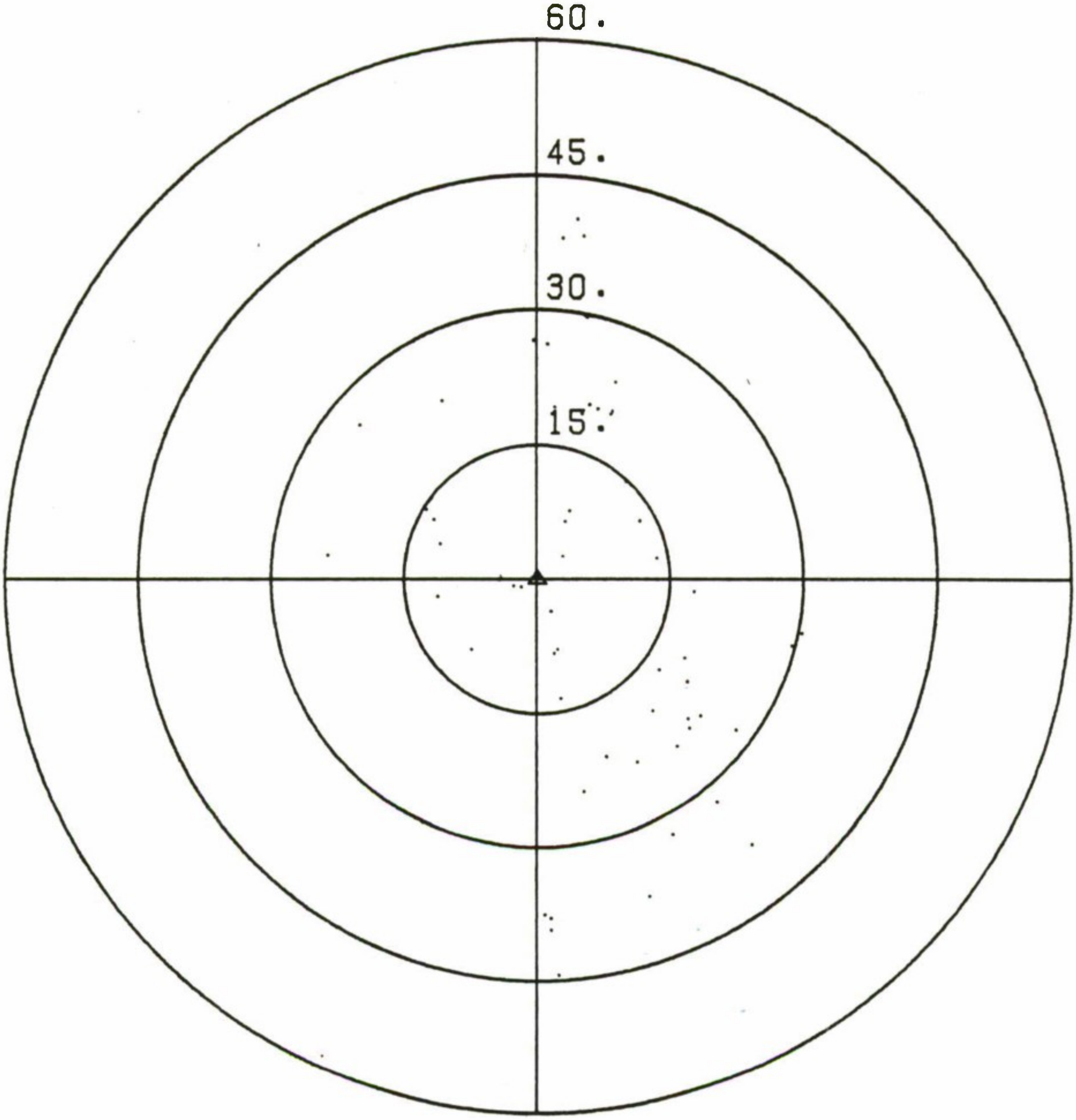

| | |
|---|---|
| TOTAL NUMBER OF TCAS = | 188 |
| NUMBER OF TCAS THAT EXPERIENCE INTERFERENCE-LIMITING = | 133 |

Figure C-2. Location of TCAS-equipped A/C that experienced interference-limiting; Density = 0.159 A/C per square nmi, 25% DABS (25% TCAS). See TABLE C-3.




| | |
|---|---|
| TOTAL NUMBER OF TCAS = | 87 |
| NUMBER OF TCAS THAT EXPERIENCE INTERFERENCE-LIMITING = | 36 |

Figure C-3. Location of TCAS-equipped A/C that experienced interference-limiting; Density = 0.08 A/C per square nmi, 25% DABS (25% TCAS). See TABLE C-6.




| | |
|---|---|
| TOTAL NUMBER OF TCAS | = 87 |
| NUMBER OF TCAS THAT EXPERIENCE INTERFERENCE-LIMITING | = 58 |

Figure C-4. Location of TCAS-equipped A/C that experienced interference-limiting; Density = 0.08 A/C per square nmi, 54% DABS (25% TCAS). See TABLE C-8.

## TABLE C-1

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .66425 | 2.06149 | 24218. | .03482 | 1.83 | 500. |
| .60665 | 2.05881 | 28719. | .02371 | 1.43 | 500. |
| .59980 | 2.03244 | 9000. | .02016 | 4.54 | 500. |
| .59655 | 2.03389 | 8502. | .04350 | 6.87 | 500. |
| .59541 | 2.05044 | 7500. | .01874 | 7.43 | 500. |
| .59266 | 2.05525 | 6000. | .09438 | 11.82 | 500. |
| .59005 | 2.06067 | 1998. | .15314 | 16.92 | 125. |
| .58765 | 2.05206 | 16000. | .05730 | .35 | 500. |
| .58621 | 2.05547 | 10992. | .10009 | .87 | 500. |
| .58422 | 2.05830 | 3503. | .11565 | 29.90 | 500. |
| .58967 | 2.06168 | 1494. | .15633 | 18.57 | 125. |
| .58099 | 2.05859 | 23851. | .08842 | .01 | 500. |
| .58198 | 2.03949 | 10994. | .18083 | 2.94 | 500. |
| .58674 | 2.05119 | 10494. | .14854 | 8.30 | 500. |
| .58467 | 2.06087 | 18320. | .12591 | .57 | 500. |
| .58433 | 2.06116 | 2479. | .12379 | 11.87 | 125. |
| .58242 | 2.06188 | 3992. | .10610 | 9.92 | 125. |
| .58521 | 2.06215 | 3506. | .13793 | 19.96 | 125. |
| .57477 | 2.06323 | 4006. | .02476 | 3.37 | 500. |
| .58550 | 2.05251 | 5493. | .14147 | 19.36 | 125. |
| .57909 | 2.06605 | 9492. | .06189 | 5.55 | 500. |
| .57905 | 2.06616 | 5500. | .06189 | 13.44 | 500. |
| .58768 | 2.06303 | 5491. | .15385 | 21.47 | 125. |
| .58157 | 2.06594 | 1268. | .09256 | 17.03 | 500. |
| .57821 | 2.06914 | 24486. | .03537 | .12 | 500. |
| .58717 | 2.06641 | 4504. | .15279 | 14.34 | 125. |
| .58614 | 2.06847 | 7539. | .14036 | 11.32 | 500. |
| .58873 | 2.06555 | 4283. | .15845 | 17.07 | 125. |
| .58861 | 2.07280 | 7000. | .08559 | 7.26 | 500. |
| .55004 | 2.06573 | 2861. | .16269 | 13.58 | 31. |
| .59020 | 2.06583 | 3876. | .16411 | 17.19 | 31. |
| .55033 | 2.06907 | 6000. | .14748 | 12.76 | 125. |
| .59202 | 2.08046 | 2500. | .03289 | 3.36 | 500. |
| .55040 | 2.06322 | 2503. | .16032 | 14.36 | 31. |
| .59210 | 2.07871 | 16000. | .03678 | .27 | 500. |
| .55358 | 2.08122 | 2698. | .03077 | 3.47 | 500. |
| .55112 | 2.06602 | 2943. | .16349 | 20.67 | 31. |
| .55168 | 2.06706 | 2920. | .15916 | 17.55 | 31. |
| .59155 | 2.06592 | 1344. | .16537 | 20.61 | 31. |
| .55232 | 2.06814 | 2987. | .15067 | 18.34 | 31. |
| .59216 | 2.06756 | 1919. | .15526 | 15.70 | 31. |
| .59568 | 2.07684 | 3008. | .05659 | 9.14 | 500. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59378 | 2.07125 | 800. | .12379 | 5.46 | 125. |
| .59237 | 2.06740 | 1289. | .15597 | 18.15 | 125. |
| .59260 | 2.05792 | 1066. | .15137 | 17.22 | 125. |
| .59234 | 2.06710 | 656. | .15845 | 17.13 | 125. |
| .59591 | 2.07604 | 8502. | .06139 | 3.94 | 125. |
| .55920 | 2.08409 | 9500. | .01981 | 3.05 | 500. |
| .59374 | 2.07631 | 3655. | .13229 | 9.71 | 125. |
| .59584 | 2.07452 | 8491. | .07215 | 6.10 | 125. |
| .59486 | 2.07386 | 4996. | .12308 | 8.64 | 125. |
| .59230 | 2.06564 | 100. | .16446 | 17.87 | 31. |
| .55525 | 2.07815 | 11002. | .04987 | 7.93 | 500. |
| .59256 | 2.06577 | 100. | .16234 | 16.06 | 31. |
| .59759 | 2.07349 | 4995. | .09514 | 9.64 | 125. |
| .60129 | 2.07925 | 17000. | .03743 | 1.23 | 500. |
| .55411 | 2.06753 | 6438. | .15431 | 12.97 | 31. |
| .59742 | 2.07222 | 9500. | .10787 | 7.14 | 125. |
| .59366 | 2.06675 | 3988. | .15845 | 18.91 | 31. |
| .59854 | 2.07306 | 5003. | .09858 | 7.75 | 125. |
| .59718 | 2.07057 | 23000. | .12096 | 5.16 | 500. |
| .60237 | 2.07633 | 21000. | .04173 | 2.54 | 500. |
| .55837 | 2.07026 | 7004. | .11707 | 6.50 | 125. |
| .60432 | 2.07462 | 24080. | .04421 | 1.56 | 500. |
| .60412 | 2.07430 | 6147. | .04895 | 8.07 | 500. |
| .60118 | 2.07111 | 5497. | .09196 | 5.27 | 125. |
| .60485 | 2.07389 | 7580. | .04492 | 7.76 | 500. |
| .59481 | 2.06520 | 3800. | .15562 | 12.17 | 31. |
| .59568 | 2.06547 | 8000. | .14678 | 12.78 | 125. |
| .60196 | 2.06948 | 24090. | .08594 | 1.00 | 500. |
| .60202 | 2.06907 | 7177. | .08524 | 17.91 | 500. |
| .60008 | 2.06783 | 23994. | .11070 | 5.61 | 500. |
| .60225 | 2.05870 | 3818. | .08028 | 5.47 | 125. |
| .55715 | 2.06445 | 2995. | .13475 | 13.81 | 125. |
| .59825 | 2.06440 | 6236. | .12343 | 15.22 | 125. |
| .55810 | 2.06408 | 689. | .12556 | 10.59 | 125. |
| .59697 | 2.06370 | 8996. | .13723 | 12.55 | 125. |
| .59814 | 2.06385 | 558. | .12449 | 10.23 | 125. |
| .60105 | 2.06448 | 3994. | .09136 | 10.72 | 125. |
| .60146 | 2.06414 | 4292. | .08382 | 8.53 | 125. |
| .60122 | 2.06308 | 10498. | .07922 | 8.86 | 500. |
| .55894 | 2.06266 | 2806. | .11565 | 10.81 | 125. |
| .59376 | 2.06220 | 2151. | .15420 | 13.45 | 125. |

TABLE C-2

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR | LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| .60425 | 2.06149 | 24218. | .05482 | 1.94 | 500. | .59378 | 2.07125 | 800. | .12379 | 18.15 | 500. |
| .60565 | 2.03891 | 29719. | .02771 | 1.62 | 500. | .59237 | 2.05740 | 1289. | .15577 | 40.24 | 500. |
| .57980 | 2.03244 | 7000. | .02016 | 4.53 | 500. | .59260 | 2.04792 | 1065. | .15137 | 37.92 | 500. |
| .59555 | 2.03399 | 8502. | .04350 | 5.16 | 500. | .59234 | 2.05710 | 656. | .15845 | 35.73 | 500. |
| .59541 | 2.03044 | 7500. | .01974 | 7.43 | 500. | .59591 | 2.07604 | 8502. | .06189 | 19.60 | 500. |
| .59266 | 2.07525 | 6000. | .09408 | 12.02 | 500. | .59920 | 2.09409 | 9500. | .01781 | 3.46 | 500. |
| .59005 | 2.06067 | 1998. | .15314 | 51.14 | 500. | .59374 | 2.07031 | 3655. | .13228 | 40.78 | 500. |
| .59765 | 2.09205 | 15000. | .07730 | .38 | 500. | .59594 | 2.07492 | 9491. | .07215 | 13.10 | 500. |
| .58521 | 2.05547 | 10992. | .10039 | .85 | 500. | .59486 | 2.07085 | 4996. | .12309 | 34.91 | 500. |
| .59422 | 2.03830 | 3303. | .11555 | 27.26 | 500. | .59230 | 2.05564 | 100. | .15446 | 42.93 | 500. |
| .58767 | 2.05158 | 1494. | .15533 | 61.10 | 500. | .59925 | 2.07815 | 11002. | .04987 | 8.09 | 500. |
| .59099 | 2.05899 | 23851. | .03842 | .01 | 500. | .59255 | 2.05577 | 100. | .15234 | 37.53 | 500. |
| .59198 | 2.03949 | 10994. | .10080 | 3.13 | 500. | .59759 | 2.07349 | 4995. | .09514 | 19.22 | 500. |
| .58574 | 2.05119 | 10494. | .14854 | 7.96 | 500. | .60129 | 2.07729 | 17000. | .03749 | 1.17 | 500. |
| .58467 | 2.06087 | 19320. | .12571 | .60 | 500. | .59411 | 2.05733 | 6438. | .13491 | 38.93 | 500. |
| .58433 | 2.05116 | 2470. | .12379 | 42.30 | 500. | .59742 | 2.07222 | 9500. | .10787 | 17.71 | 500. |
| .59242 | 2.05188 | 3592. | .10510 | 38.03 | 500. | .59366 | 2.05679 | 3988. | .13345 | 52.67 | 500. |
| .58521 | 2.06215 | 3506. | .13793 | 47.88 | 500. | .59854 | 2.07306 | 5003. | .09959 | 21.26 | 500. |
| .57477 | 2.05323 | 4006. | .02476 | 3.36 | 500. | .59718 | 2.07057 | 23000. | .12096 | 5.33 | 500. |
| .59550 | 2.05251 | 5493. | .14147 | 44.46 | 500. | .60237 | 2.07533 | 21000. | .04173 | 2.70 | 500. |
| .57909 | 2.06605 | 9492. | .05199 | 5.86 | 500. | .59837 | 2.07026 | 7004. | .11707 | 25.97 | 500. |
| .57905 | 2.05616 | 5500. | .06139 | 13.61 | 500. | .60432 | 2.07452 | 24000. | .04421 | 1.62 | 500. |
| .59768 | 2.05303 | 5491. | .15385 | 68.86 | 500. | .60412 | 2.07430 | 6147. | .03845 | 7.82 | 500. |
| .58157 | 2.06594 | 1268. | .09256 | 17.08 | 500. | .60119 | 2.07111 | 5497. | .09196 | 18.53 | 500. |
| .57821 | 2.05914 | 24486. | .03537 | .08 | 500. | .60495 | 2.07399 | 7500. | .04492 | 7.99 | 500. |
| .58717 | 2.05641 | 4504. | .15279 | 47.19 | 500. | .59481 | 2.05520 | 3800. | .15562 | 68.99 | 500. |
| .58514 | 2.06947 | 7539. | .14006 | 10.82 | 500. | .59568 | 2.06547 | 8000. | .14678 | 29.23 | 500. |
| .59873 | 2.05555 | 4203. | .15945 | 61.75 | 500. | .60196 | 2.06748 | 24000. | .09594 | 2.82 | 500. |
| .58861 | 2.07280 | 7000. | .08559 | 5.83 | 500. | .60202 | 2.05907 | 7177. | .08524 | 17.53 | 500. |
| .59004 | 2.05573 | 2861. | .16269 | 59.14 | 500. | .60008 | 2.05780 | 23994. | .11070 | 5.93 | 500. |
| .59020 | 2.06580 | 3876. | .16411 | 62.90 | 500. | .60229 | 2.05970 | 3810. | .08028 | 19.80 | 500. |
| .59033 | 2.05707 | 6000. | .14748 | 40.27 | 500. | .59715 | 2.05445 | 2995. | .13475 | 37.34 | 500. |
| .59202 | 2.08046 | 2500. | .03289 | 3.24 | 500. | .59925 | 2.05440 | 6236. | .12343 | 36.85 | 500. |
| .59040 | 2.05322 | 2503. | .15092 | 67.47 | 500. | .59810 | 2.05408 | 689. | .12556 | 24.07 | 500. |
| .59210 | 2.07871 | 16000. | .03578 | .20 | 500. | .59697 | 2.05370 | 8996. | .13723 | 23.70 | 500. |
| .59358 | 2.08122 | 2698. | .03077 | 3.29 | 500. | .59814 | 2.05385 | 558. | .12449 | 22.96 | 500. |
| .59112 | 2.06602 | 2943. | .16340 | 48.09 | 500. | .60105 | 2.05448 | 3994. | .09135 | 32.40 | 500. |
| .59168 | 2.06705 | 2920. | .15915 | 59.04 | 500. | .60146 | 2.05419 | 4292. | .08382 | 31.01 | 500. |
| .59155 | 2.06592 | 1344. | .16597 | 44.58 | 500. | .60122 | 2.05308 | 10498. | .07922 | 9.84 | 500. |
| .59232 | 2.06914 | 2987. | .15057 | 42.96 | 500. | .59894 | 2.05266 | 2806. | .11565 | 27.05 | 500. |
| .59216 | 2.05756 | 1919. | .15526 | 43.84 | 500. | .59376 | 2.05220 | 2151. | .13420 | 37.92 | 500. |
| .59568 | 2.07684 | 3008. | .05659 | 9.05 | 500. | | | | | | |

TABLE C-3

(Page 1 of 2)

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .60425 | 2.06149 | 24218. | .05482 | 2.11 | 500. |
| .59329 | 2.06173 | 1255. | .15739 | 5.63 | 31. |
| .60665 | 2.05881 | 28719. | .02971 | 1.50 | 500. |
| .59700 | 2.05952 | 7493. | .10929 | 8.97 | 500. |
| .60129 | 2.05454 | 5922. | .03714 | 4.57 | 500. |
| .59342 | 2.05962 | 10497. | .14501 | 7.77 | 500. |
| .59063 | 2.06162 | 1266. | .15951 | 7.96 | 31. |
| .59220 | 2.06027 | 2991. | .15314 | 5.91 | 31. |
| .59980 | 2.05244 | 9000. | .02016 | 4.60 | 500. |
| .59655 | 2.05389 | 8502. | .04350 | 2.72 | 125. |
| .59720 | 2.05280 | 2500. | .02723 | 6.95 | 500. |
| .59704 | 2.05230 | 8493. | .02193 | 6.40 | 500. |
| .59527 | 2.05253 | 5427. | .03183 | 6.84 | 125. |
| .59560 | 2.05145 | 3500. | .02122 | 7.54 | 500. |
| .59581 | 2.05036 | 2885. | .01733 | 5.28 | 500. |
| .59541 | 2.05044 | 7500. | .01874 | 7.47 | 500. |
| .59266 | 2.05525 | 6000. | .09408 | 11.81 | 500. |
| .59255 | 2.05425 | 1621. | .08099 | 9.98 | 500. |
| .59135 | 2.05608 | 3405. | .11459 | 7.31 | 125. |
| .59082 | 2.05606 | 3405. | .11601 | 12.64 | 500. |
| .59043 | 2.05645 | 3401. | .12237 | 7.72 | 125. |
| .59005 | 2.06067 | 1998. | .15314 | 12.32 | 31. |
| .58765 | 2.05206 | 16000. | .05730 | .37 | 500. |
| .58890 | 2.05764 | 4480. | .13228 | 9.56 | 125. |
| .58621 | 2.05547 | 10992. | .10009 | .76 | 500. |
| .58928 | 2.06358 | 1097. | .14784 | 15.90 | 31. |
| .58790 | 2.05986 | 1694. | .14147 | 11.52 | 31. |
| .58773 | 2.05865 | 1693. | .13652 | 11.34 | 31. |
| .58818 | 2.06005 | 1692. | .14819 | 14.27 | 31. |
| .58011 | 2.05417 | 3003. | .03608 | 5.66 | 500. |
| .58253 | 2.05610 | 5492. | .08524 | 9.73 | 500. |
| .58741 | 2.05992 | 2994. | .14572 | 12.42 | 31. |
| .58246 | 2.05667 | 6498. | .08983 | 12.16 | 500. |
| .58808 | 2.06053 | 1997. | .14819 | 15.44 | 31. |
| .58398 | 2.05805 | 4513. | .11247 | 9.51 | 125. |
| .58422 | 2.05830 | 3503. | .11565 | 9.04 | 125. |
| .58289 | 2.05753 | 3496. | .09832 | 6.21 | 125. |
| .58778 | 2.06048 | 1225. | .14784 | 15.35 | 31. |
| .58537 | 2.05941 | 3003. | .12945 | 7.04 | 31. |
| .58967 | 2.06168 | 1494. | .15633 | 13.75 | 31. |
| .58099 | 2.05899 | 23851. | .08842 | .01 | 500. |
| .58720 | 2.06396 | 0. | .14854 | 16.63 | 31. |
| .58198 | 2.05949 | 10994. | .10080 | 2.83 | 500. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .58734 | 2.06118 | 3995. | .14961 | 20.08 | 31. |
| .58674 | 2.06119 | 10494. | .14854 | 7.85 | 500. |
| .58467 | 2.06387 | 18320. | .12591 | .51 | 500. |
| .58433 | 2.06116 | 2470. | .12379 | 8.80 | 31. |
| .57421 | 2.06168 | 5316. | .02157 | 2.32 | 500. |
| .58242 | 2.06188 | 3992. | .10610 | 8.97 | 125. |
| .58833 | 2.06193 | 4500. | .15137 | 18.82 | 31. |
| .58229 | 2.06207 | 1994. | .10575 | 8.89 | 125. |
| .58440 | 2.06210 | 1997. | .12697 | 8.07 | 31. |
| .58521 | 2.06215 | 3506. | .13793 | 14.41 | 31. |
| .57477 | 2.06323 | 4006. | .02476 | 3.52 | 500. |
| .58550 | 2.06251 | 5493. | .14147 | 14.90 | 31. |
| .58016 | 2.06353 | 4497. | .08265 | 6.43 | 125. |
| .58667 | 2.06254 | 1451. | .15067 | 14.04 | 31. |
| .58518 | 2.06284 | 9500. | .13935 | 7.84 | 125. |
| .58706 | 2.06257 | 8492. | .15137 | 12.35 | 31. |
| .57658 | 2.06532 | 6004. | .03643 | 9.18 | 500. |
| .58147 | 2.06413 | 2597. | .09797 | 11.77 | 125. |
| .58020 | 2.06520 | 2603. | .07392 | 9.22 | 125. |
| .58624 | 2.06330 | 3498. | .14996 | 14.55 | 31. |
| .57972 | 2.06563 | 2503. | .06826 | 8.96 | 125. |
| .57931 | 2.06594 | 2228. | .06402 | 7.01 | 125. |
| .57909 | 2.06605 | 9492. | .06169 | 5.80 | 500. |
| .57905 | 2.06616 | 5500. | .06189 | 6.52 | 125. |
| .58105 | 2.06572 | 13494. | .08700 | 1.70 | 500. |
| .58768 | 2.06303 | 5491. | .15385 | 17.29 | 31. |
| .58119 | 2.06592 | 2166. | .08736 | 9.10 | 125. |
| .58157 | 2.06594 | 1268. | .09266 | 7.55 | 125. |
| .58399 | 2.06499 | 2505. | .12485 | 5.95 | 125. |
| .58169 | 2.06618 | 704. | .09231 | 7.74 | 125. |
| .58645 | 2.06397 | 304. | .15067 | 7.37 | 31. |
| .58688 | 2.06375 | 6495. | .15244 | 15.23 | 31. |
| .58658 | 2.06408 | 908. | .15137 | 8.68 | 31. |
| .57821 | 2.06914 | 24486. | .03537 | .08 | 500. |
| .58572 | 2.06465 | 7491. | .14289 | 10.79 | 31. |
| .58717 | 2.06641 | 4504. | .15279 | 8.74 | 31. |
| .58614 | 2.06847 | 7539. | .14006 | 11.31 | 500. |
| .58905 | 2.06386 | 1096. | .15986 | 12.85 | 31. |
| .58873 | 2.06555 | 4203. | .15845 | 9.28 | 31. |
| .58938 | 2.06497 | 2495. | .16092 | 10.54 | 31. |
| .58972 | 2.06419 | 7496. | .16340 | 9.84 | 31. |
| .58861 | 2.07260 | 7000. | .08559 | 6.28 | 500. |
| .59004 | 2.06573 | 2861. | .16269 | 13.76 | 31. |
| .59005 | 2.07054 | 10492. | .12839 | 6.30 | 500. |

TABLE C-3

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| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59020 | 2.06540 | 3876. | .16411 | 17.64 | 31. |
| .59033 | 2.06907 | 6000. | .14748 | 8.40 | 31. |
| .59032 | 2.06567 | 8500. | .16375 | 6.22 | 31. |
| .59202 | 2.08046 | 2500. | .03289 | 3.29 | 500. |
| .59040 | 2.06322 | 2503. | .16092 | 14.33 | 31. |
| .59210 | 2.07871 | 16000. | .03678 | .25 | 500. |
| .59358 | 2.08122 | 2698. | .03077 | 3.34 | 500. |
| .59268 | 2.07368 | 9494. | .07746 | 2.74 | 125. |
| .59112 | 2.06602 | 2943. | .16340 | .00 | 0. |
| .59205 | 2.07040 | 7010. | .12980 | 9.02 | 125. |
| .59402 | 2.07891 | 4502. | .03961 | 3.09 | 125. |
| .59338 | 2.07475 | 4603. | .06720 | 3.27 | 125. |
| .59475 | 2.07916 | 8494. | .03997 | 7.93 | 500. |
| .59168 | 2.06706 | 2920. | .15916 | 17.79 | 31. |
| .59072 | 2.06353 | 4496. | .16022 | 17.67 | 31. |
| .59607 | 2.08040 | 8498. | .03678 | 9.21 | 500. |
| .59155 | 2.06592 | 1344. | .16587 | .00 | 0. |
| .59232 | 2.06814 | 2987. | .15067 | 18.00 | 31. |
| .59216 | 2.06756 | 1919. | .15526 | 16.58 | 31. |
| .59568 | 2.07684 | 3008. | .05659 | 1.98 | 125. |
| .59378 | 2.07125 | 800. | .12379 | 5.58 | 125. |
| .59237 | 2.06740 | 1289. | .15597 | 15.55 | 31. |
| .59260 | 2.06792 | 1066. | .15137 | 14.08 | 31. |
| .59843 | 2.08266 | 8497. | .02617 | 4.96 | 500. |
| .59234 | 2.06710 | 656. | .15845 | 13.38 | 31. |
| .59591 | 2.07604 | 8502. | .06189 | 3.77 | 125. |
| .59736 | 2.07948 | 23000. | .04315 | .50 | 500. |
| .59920 | 2.08409 | 9500. | .01981 | 3.17 | 500. |
| .59374 | 2.07031 | 3655. | .13228 | 10.14 | 125. |
| .59584 | 2.07492 | 8491. | .07215 | 6.10 | 125. |
| .59909 | 2.08227 | 9500. | .02865 | 5.57 | 500. |
| .59453 | 2.07057 | 8495. | .12874 | 7.10 | 125. |
| .59705 | 2.07550 | 4007. | .06755 | 6.45 | 125. |
| .59486 | 2.07086 | 4996. | .12308 | 8.10 | 125. |
| .59230 | 2.06564 | 100. | .16446 | 17.63 | 31. |
| .59925 | 2.07815 | 11002. | .04987 | 7.86 | 500. |
| .59659 | 2.07292 | 6495. | .10257 | 9.47 | 125. |
| .59256 | 2.06517 | 100. | .16234 | 16.44 | 31. |
| .59682 | 2.07246 | 7464. | .10681 | 7.83 | 125. |
| .59759 | 2.07349 | 4995. | .09514 | 8.43 | 125. |
| .60129 | 2.07925 | 17000. | .03749 | 1.15 | 500. |
| .59411 | 2.06753 | 6438. | .15491 | 13.50 | 31. |
| .59742 | 2.07222 | 9500. | .10787 | 7.10 | 125. |
| .59366 | 2.06675 | 3988. | .15845 | 18.72 | 31. |
| .59854 | 2.07306 | 5003. | .09868 | 7.96 | 125. |
| .60015 | 2.07460 | 8494. | .07357 | 4.29 | 125. |
| .59718 | 2.07057 | 23000. | .12096 | 5.29 | 500. |
| .60148 | 2.07574 | 9500. | .05305 | 1.81 | 125. |
| .59373 | 2.06610 | 5679. | .16092 | 20.40 | 31. |
| .59411 | 2.06656 | 10492. | .15739 | 7.04 | 125. |
| .60237 | 2.07633 | 21000. | .04173 | 2.64 | 500. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59334 | 2.06546 | 8500. | .16234 | 7.37 | 31. |
| .59213 | 2.06394 | 2188. | .16517 | 14.83 | 31. |
| .59837 | 2.07026 | 7004. | .11707 | 6.47 | 125. |
| .59374 | 2.06536 | 2991. | .16022 | 15.79 | 31. |
| .60432 | 2.07462 | 24000. | .04421 | 1.43 | 500. |
| .60423 | 2.07444 | 4492. | .04527 | 6.61 | 500. |
| .60412 | 2.07430 | 6147. | .04845 | 8.52 | 500. |
| .60380 | 2.07349 | 6500. | .05553 | 3.67 | 125. |
| .60118 | 2.07111 | 5497. | .09196 | 4.92 | 125. |
| .59446 | 2.06536 | 2593. | .15845 | 11.84 | 31. |
| .60485 | 2.07389 | 7500. | .04492 | 7.99 | 500. |
| .59481 | 2.06520 | 3800. | .15562 | 11.99 | 31. |
| .59818 | 2.06758 | 19994. | .12732 | 3.63 | 500. |
| .59568 | 2.06547 | 8000. | .14678 | 10.08 | 31. |
| .60196 | 2.06948 | 24000. | .08594 | 2.66 | 500. |
| .60202 | 2.06907 | 7177. | .08524 | 7.67 | 125. |
| .60008 | 2.06780 | 23994. | .11070 | 5.51 | 500. |
| .60229 | 2.06870 | 3810. | .08028 | 5.47 | 125. |
| .59817 | 2.06577 | 3493. | .12520 | 10.79 | 31. |
| .60032 | 2.06663 | 6495. | .10646 | 11.97 | 125. |
| .59829 | 2.06563 | 4496. | .12379 | 16.72 | 31. |
| .59470 | 2.06375 | 2597. | .15491 | 10.58 | 31. |
| .60019 | 2.06606 | 4541. | .10893 | 11.17 | 31. |
| .60218 | 2.06643 | 3495. | .07781 | 12.30 | 125. |
| .59715 | 2.06445 | 2995. | .13475 | 10.85 | 31. |
| .59794 | 2.06469 | 1017. | .12697 | 8.41 | 31. |
| .59900 | 2.06473 | 6497. | .12025 | 16.90 | 31. |
| .59825 | 2.06440 | 6236. | .12343 | 11.42 | 31. |
| .59810 | 2.06408 | 689. | .12556 | 7.80 | 31. |
| .60000 | 2.07000 | 4396. | .10646 | 7.25 | 125. |
| .59697 | 2.06370 | 8996. | .13723 | 10.01 | 31. |
| .60363 | 2.06544 | 3007. | .06331 | 4.74 | 125. |
| .59814 | 2.06385 | 558. | .12449 | 7.95 | 31. |
| .60112 | 2.06458 | 2303. | .09125 | 10.13 | 125. |
| .60020 | 2.06432 | 4500. | .10964 | 14.77 | 31. |
| .59703 | 2.06354 | 9494. | .13652 | 10.31 | 31. |
| .60715 | 2.06597 | 5097. | .04350 | 8.51 | 500. |
| .60105 | 2.06448 | 3994. | .09196 | 10.83 | 125. |
| .60424 | 2.06486 | 1341. | .05906 | 3.08 | 125. |
| .59798 | 2.06350 | 5830. | .12626 | 11.94 | 31. |
| .60369 | 2.06461 | 5494. | .06083 | 5.46 | 125. |
| .60146 | 2.06414 | 4292. | .08362 | 9.15 | 125. |
| .59576 | 2.06292 | 4497. | .14784 | 12.11 | 31. |
| .60751 | 2.06510 | 9500. | .04244 | 3.94 | 500. |
| .59896 | 2.06335 | 8500. | .11813 | 11.40 | 125. |
| .59447 | 2.06241 | 7500. | .15208 | 8.67 | 125. |
| .60122 | 2.06308 | 10498. | .07922 | 1.86 | 125. |
| .59894 | 2.06266 | 2806. | .11565 | 10.97 | 125. |
| .59376 | 2.06220 | 2151. | .15420 | 7.40 | 31. |
| .60893 | 2.06299 | 8500. | .02759 | 3.32 | 500. |

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| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .60425 | 2.06149 | 24218. | .05482 | 2.04 | 500. |
| .59329 | 2.06173 | 1255. | .15739 | 41.22 | 500. |
| .60665 | 2.05881 | 28719. | .02971 | 1.47 | 500. |
| .59700 | 2.05852 | 7493. | .10929 | 9.63 | 500. |
| .60129 | 2.05454 | 5922. | .03714 | 3.59 | 500. |
| .59342 | 2.05962 | 10497. | .14501 | 7.29 | 500. |
| .59063 | 2.06162 | 1266. | .15951 | 60.07 | 500. |
| .59220 | 2.06027 | 2991. | .15314 | 34.21 | 500. |
| .59980 | 2.05244 | 9000. | .02816 | 4.50 | 500. |
| .59655 | 2.05789 | 8502. | .04350 | 6.76 | 500. |
| .59720 | 2.05280 | 2500. | .02723 | 6.99 | 500. |
| .59704 | 2.05230 | 8493. | .02193 | 6.31 | 500. |
| .59527 | 2.05253 | 5427. | .03183 | 11.58 | 500. |
| .59560 | 2.05145 | 3500. | .02122 | 7.42 | 500. |
| .59581 | 2.05036 | 2885. | .01733 | 5.39 | 500. |
| .59541 | 2.05044 | 7500. | .01874 | 7.31 | 500. |
| .59266 | 2.05525 | 6000. | .09408 | 13.41 | 500. |
| .59255 | 2.05425 | 1621. | .08099 | 9.26 | 500. |
| .59135 | 2.05608 | 3405. | .11459 | 13.90 | 500. |
| .59082 | 2.05606 | 3405. | .11601 | 11.41 | 500. |
| .59043 | 2.05645 | 3401. | .12237 | 25.24 | 500. |
| .59005 | 2.06067 | 1998. | .15314 | 49.85 | 500. |
| .58765 | 2.05206 | 16000. | .05730 | .27 | 500. |
| .58890 | 2.05764 | 4460. | .13228 | 34.84 | 500. |
| .58621 | 2.05547 | 10992. | .10009 | 1.41 | 500. |
| .58928 | 2.06056 | 1097. | .14764 | 42.73 | 500. |
| .58790 | 2.05886 | 1694. | .14147 | 36.14 | 500. |
| .58773 | 2.05865 | 1693. | .13652 | 36.08 | 500. |
| .58818 | 2.06005 | 1692. | .14819 | 46.58 | 500. |
| .58011 | 2.05417 | 3003. | .03608 | 4.85 | 500. |
| .58253 | 2.05610 | 5492. | .08524 | 9.48 | 500. |
| .58741 | 2.05992 | 2994. | .14572 | 53.81 | 500. |
| .58246 | 2.05667 | 6498. | .08983 | 11.43 | 500. |
| .58808 | 2.06053 | 1997. | .14819 | 47.58 | 500. |
| .58398 | 2.05805 | 4513. | .11247 | 22.02 | 500. |
| .56422 | 2.05830 | 3503. | .11565 | 30.03 | 500. |
| .58289 | 2.05753 | 3496. | .09832 | 15.76 | 500. |
| .58778 | 2.06048 | 1225. | .14784 | 50.64 | 500. |
| .58537 | 2.05941 | 3003. | .12945 | 42.96 | 500. |
| .58967 | 2.06168 | 1494. | .15633 | 59.86 | 500. |
| .58099 | 2.05899 | 23851. | .08642 | .01 | 500. |
| .58720 | 2.06096 | 0. | .14854 | 40.50 | 500. |
| .58198 | 2.05949 | 10994. | .10080 | 2.93 | 500. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .58734 | 2.06118 | 3995. | .14961 | 55.19 | 500. |
| .58674 | 2.06119 | 10494. | .14854 | 7.98 | 500. |
| .58467 | 2.06087 | 18320. | .12591 | .57 | 500. |
| .58433 | 2.06116 | 2470. | .12379 | 43.67 | 500. |
| .57421 | 2.06168 | 5316. | .02157 | 2.87 | 500. |
| .58242 | 2.06188 | 3992. | .10610 | 36.49 | 500. |
| .58833 | 2.06193 | 4500. | .15137 | 66.50 | 500. |
| .58229 | 2.06207 | 1994. | .10575 | 28.31 | 500. |
| .58440 | 2.06210 | 1997. | .12697 | 43.80 | 500. |
| .58521 | 2.06215 | 3506. | .13793 | 48.11 | 500. |
| .57477 | 2.06323 | 4006. | .02476 | 3.71 | 500. |
| .58550 | 2.06251 | 5493. | .14147 | 45.41 | 500. |
| .58016 | 2.06353 | 4497. | .08205 | 17.04 | 500. |
| .58667 | 2.06254 | 1451. | .15067 | 50.22 | 500. |
| .58518 | 2.06284 | 9500. | .13935 | 15.75 | 500. |
| .58706 | 2.06257 | 8492. | .15137 | 22.52 | 500. |
| .57658 | 2.06532 | 6004. | .03643 | 8.90 | 500. |
| .58147 | 2.06413 | 2597. | .09797 | 20.12 | 500. |
| .58020 | 2.06520 | 2603. | .07392 | 16.96 | 500. |
| .58624 | 2.06330 | 3498. | .14996 | 53.68 | 500. |
| .57972 | 2.06563 | 2503. | .06826 | 12.98 | 500. |
| .57931 | 2.06594 | 2228. | .06402 | 12.30 | 500. |
| .57909 | 2.06605 | 9492. | .06189 | 6.51 | 500. |
| .57905 | 2.06616 | 5500. | .06189 | 14.50 | 500. |
| .58105 | 2.06572 | 13494. | .08700 | 2.20 | 500. |
| .58768 | 2.06303 | 5491. | .15385 | 68.33 | 500. |
| .58119 | 2.06592 | 2166. | .08736 | 16.46 | 500. |
| .56157 | 2.06594 | 1268. | .09266 | 16.91 | 500. |
| .58399 | 2.06499 | 2505. | .12485 | 34.64 | 500. |
| .58169 | 2.06618 | 704. | .09231 | 16.62 | 500. |
| .58645 | 2.06397 | 304. | .15067 | 41.48 | 500. |
| .58688 | 2.06375 | 6495. | .15244 | 46.89 | 500. |
| .58658 | 2.06408 | 908. | .15137 | 43.96 | 500. |
| .57821 | 2.06914 | 24486. | .03537 | .07 | 500. |
| .58572 | 2.06465 | 7491. | .14289 | 32.32 | 500. |
| .58717 | 2.06641 | 4504. | .15279 | 46.36 | 500. |
| .58614 | 2.06847 | 7539. | .14006 | 10.98 | 500. |
| .58905 | 2.06386 | 1096. | .15986 | 60.29 | 500. |
| .58873 | 2.06555 | 4203. | .15845 | 63.02 | 500. |
| .58938 | 2.06497 | 2495. | .16092 | 69.58 | 500. |
| .58972 | 2.06419 | 7496. | .16340 | 34.20 | 500. |
| .58861 | 2.07280 | 7000. | .08559 | 6.91 | 500. |
| .59004 | 2.06573 | 2861. | .16269 | 59.34 | 500. |
| .59005 | 2.07054 | 10492. | .12839 | 7.38 | 500. |

TABLE C-4

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| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59020 | 2.06580 | 3876. | .16411 | 66.18 | 500. |
| .59033 | 2.06907 | 6000. | .14748 | 39.26 | 500. |
| .59032 | 2.06567 | 8500. | .16375 | 30.15 | 500. |
| .59202 | 2.08346 | 2500. | .03289 | 3.07 | 500. |
| .59040 | 2.06322 | 2503. | .16092 | 65.83 | 500. |
| .59210 | 2.07871 | 16000. | .03678 | .30 | 500. |
| .59358 | 2.08122 | 2698. | .03077 | 3.25 | 500. |
| .59268 | 2.07368 | 9494. | .07746 | 13.63 | 500. |
| .59112 | 2.06602 | 2943. | .16340 | 49.11 | 500. |
| .59205 | 2.07040 | 7010. | .12980 | 23.21 | 500. |
| .59402 | 2.07891 | 4502. | .03961 | 11.21 | 500. |
| .59338 | 2.07475 | 4603. | .06720 | 20.30 | 500. |
| .59475 | 2.07916 | 8494. | .03997 | 7.49 | 500. |
| .59168 | 2.06706 | 2920. | .15916 | 51.11 | 500. |
| .59072 | 2.06353 | 4496. | .16022 | 72.29 | 500. |
| .59607 | 2.08040 | 8498. | .03678 | 9.48 | 500. |
| .59155 | 2.06592 | 1344. | .16587 | 46.16 | 500. |
| .59232 | 2.06814 | 2987. | .15067 | 44.88 | 500. |
| .59216 | 2.06756 | 1919. | .15526 | 43.20 | 500. |
| .59568 | 2.07684 | 3008. | .05659 | 9.04 | 500. |
| .59378 | 2.07125 | 800. | .12379 | 18.53 | 500. |
| .59237 | 2.06740 | 1289. | .15597 | 41.10 | 500. |
| .59260 | 2.06792 | 1066. | .15137 | 38.63 | 500. |
| .59843 | 2.08266 | 8497. | .02617 | 5.00 | 500. |
| .59234 | 2.06710 | 656. | .15845 | 35.98 | 500. |
| .59591 | 2.07604 | 8502. | .06189 | 19.46 | 500. |
| .59736 | 2.07948 | 23000. | .04315 | .19 | 500. |
| .59920 | 2.08409 | 9500. | .01981 | 3.23 | 500. |
| .59374 | 2.07031 | 3655. | .13228 | 39.37 | 500. |
| .59584 | 2.07492 | 8491. | .07215 | 18.38 | 500. |
| .59909 | 2.08227 | 9500. | .02865 | 5.88 | 500. |
| .59453 | 2.07057 | 8495. | .12874 | 29.06 | 500. |
| .59705 | 2.07550 | 4007. | .06755 | 13.10 | 500. |
| .59486 | 2.07086 | 4996. | .12308 | 38.25 | 500. |
| .59230 | 2.06564 | 100. | .16446 | 42.67 | 500. |
| .59925 | 2.07915 | 11002. | .04987 | 8.23 | 500. |
| .59659 | 2.07292 | 6495. | .10257 | 24.21 | 500. |
| .59256 | 2.06577 | 100. | .16234 | 38.72 | 500. |
| .59682 | 2.07246 | 7464. | .10681 | 22.38 | 500. |
| .59759 | 2.07349 | 4995. | .09514 | 19.21 | 500. |
| .60129 | 2.07925 | 17000. | .03749 | 1.28 | 500. |
| .59411 | 2.06753 | 6438. | .15491 | 39.50 | 500. |
| .59742 | 2.07222 | 9500. | .10787 | 18.78 | 500. |
| .59366 | 2.06675 | 3988. | .15845 | 52.12 | 500. |
| .59854 | 2.07306 | 5003. | .09868 | 21.67 | 500. |
| .60015 | 2.07460 | 8494. | .07357 | 14.41 | 500. |
| .59718 | 2.07057 | 23000. | .12096 | 5.34 | 500. |
| .60148 | 2.07574 | 9500. | .05305 | 10.93 | 500. |
| .59373 | 2.06610 | 5679. | .16092 | 59.34 | 500. |
| .59411 | 2.06656 | 10492. | .15739 | 15.17 | 500. |
| .60237 | 2.07633 | 21000. | .04173 | 2.69 | 500. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59334 | 2.06546 | 8500. | .16234 | 26.15 | 500. |
| .59213 | 2.06794 | 2188. | .16517 | 66.70 | 500. |
| .59837 | 2.07026 | 7004. | .11707 | 25.05 | 500. |
| .59374 | 2.06536 | 2991. | .16022 | 49.45 | 500. |
| .60432 | 2.07462 | 24000. | .04421 | 1.55 | 500. |
| .60423 | 2.07444 | 4492. | .04527 | 5.88 | 500. |
| .60412 | 2.07430 | 6147. | .04845 | 7.79 | 500. |
| .60380 | 2.07349 | 6500. | .05553 | 10.27 | 500. |
| .60118 | 2.07111 | 5497. | .09196 | 18.14 | 500. |
| .59446 | 2.06536 | 2593. | .15845 | 51.94 | 500. |
| .60485 | 2.07389 | 7500. | .04492 | 7.59 | 500. |
| .59481 | 2.06520 | 3800. | .15562 | 70.61 | 500. |
| .59818 | 2.06758 | 19994. | .12732 | 3.40 | 500. |
| .59568 | 2.06547 | 8000. | .14678 | 29.31 | 500. |
| .60196 | 2.06948 | 24000. | .08594 | 2.57 | 500. |
| .60202 | 2.06907 | 7177. | .08524 | 16.80 | 500. |
| .60008 | 2.06780 | 23994. | .11070 | 5.41 | 500. |
| .60229 | 2.06810 | 3810. | .08028 | 20.34 | 500. |
| .59817 | 2.06577 | 3493. | .12520 | 34.47 | 500. |
| .60032 | 2.06663 | 6495. | .10646 | 38.03 | 500. |
| .59829 | 2.06563 | 4496. | .12379 | 37.64 | 500. |
| .59470 | 2.06375 | 2597. | .15491 | 49.76 | 500. |
| .60019 | 2.06606 | 4541. | .10893 | 36.82 | 500. |
| .60218 | 2.06643 | 3495. | .07781 | 20.80 | 500. |
| .59715 | 2.06445 | 2995. | .13475 | 38.91 | 500. |
| .59794 | 2.06469 | 1017. | .12697 | 28.60 | 500. |
| .59900 | 2.06473 | 6497. | .12025 | 32.07 | 500. |
| .59825 | 2.06440 | 6236. | .12343 | 36.62 | 500. |
| .59810 | 2.06408 | 689. | .12556 | 26.53 | 500. |
| .60000 | 2.07000 | 4396. | .10646 | 20.55 | 500. |
| .59697 | 2.06370 | 8996. | .13723 | 20.54 | 500. |
| .60363 | 2.06544 | 3007. | .06331 | 19.29 | 500. |
| .59814 | 2.06385 | 558. | .12449 | 24.85 | 500. |
| .60112 | 2.06458 | 2303. | .09125 | 29.26 | 500. |
| .60020 | 2.06432 | 4500. | .10964 | 34.48 | 500. |
| .59703 | 2.06354 | 9494. | .13652 | 19.71 | 500. |
| .60715 | 2.06597 | 5097. | .04350 | 8.60 | 500. |
| .60105 | 2.06448 | 3994. | .09196 | 30.97 | 500. |
| .60424 | 2.06486 | 1341. | .05906 | 11.43 | 500. |
| .59798 | 2.06350 | 5830. | .12626 | 41.64 | 500. |
| .60369 | 2.06461 | 5494. | .06083 | 17.60 | 500. |
| .60146 | 2.06414 | 4292. | .08382 | 32.04 | 500. |
| .59576 | 2.06292 | 4497. | .14784 | 48.77 | 500. |
| .60751 | 2.06510 | 9500. | .04244 | 3.83 | 500. |
| .59896 | 2.06335 | 8500. | .11813 | 21.97 | 500. |
| .59447 | 2.06241 | 7500. | .15208 | 39.55 | 500. |
| .60122 | 2.06308 | 10498. | .07922 | 9.88 | 500. |
| .59894 | 2.06266 | 2806. | .11565 | 25.27 | 500. |
| .59376 | 2.06220 | 2151. | .15420 | 37.27 | 500. |
| .60893 | 2.06299 | 8500. | .02759 | 3.14 | 500. |

TABLE C-5

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .60665 | 2.03881 | 28719. | .01556 | .38 | 500. |
| .57541 | 2.05044 | 7500. | .00955 | 1.53 | 500. |
| .59005 | 2.06057 | 1998. | .08099 | 19.24 | 500. |
| .58621 | 2.05547 | 10992. | .05073 | 1.14 | 500. |
| .58967 | 2.05168 | 1494. | .08311 | 22.30 | 500. |
| .58198 | 2.05949 | 10994. | .05199 | 1.96 | 500. |
| .58674 | 2.06119 | 10454. | .07781 | 5.24 | 500. |
| .58467 | 2.05087 | 18320. | .06508 | .51 | 500. |
| .58433 | 2.06116 | 2470. | .05356 | 13.65 | 500. |
| .57477 | 2.05323 | 4006. | .01450 | .57 | 500. |
| .57705 | 2.05616 | 5500. | .03325 | 5.95 | 500. |
| .58157 | 2.06594 | 1268. | .04991 | 7.21 | 500. |
| .57821 | 2.05914 | 24486. | .02016 | .01 | 500. |
| .58514 | 2.05947 | 7539. | .07392 | 3.80 | 500. |
| .58873 | 2.05555 | 4203. | .08419 | 21.04 | 500. |
| .59020 | 2.05580 | 3876. | .08550 | 19.43 | 500. |
| .59033 | 2.05907 | 6000. | .07816 | 15.35 | 500. |
| .59202 | 2.08045 | 2500. | .01598 | 2.56 | 500. |
| .59210 | 2.07871 | 15000. | .01874 | .13 | 500. |
| .59358 | 2.08122 | 2698. | .01450 | 2.61 | 500. |
| .59155 | 2.05592 | 1344. | .08550 | 15.05 | 500. |
| .59568 | 2.07684 | 3008. | .02971 | 5.67 | 500. |
| .59237 | 2.05740 | 1289. | .09099 | 13.52 | 500. |
| .59250 | 2.05792 | 1066. | .07922 | 15.15 | 500. |
| .59234 | 2.05710 | 656. | .08276 | 12.21 | 500. |
| .59591 | 2.07604 | 8502. | .03218 | 5.61 | 500. |
| .59920 | 2.08409 | 9500. | .00894 | .27 | 500. |
| .59374 | 2.07031 | 3655. | .05861 | 14.50 | 500. |
| .59486 | 2.07086 | 4996. | .06366 | 14.81 | 500. |
| .59925 | 2.07815 | 11002. | .02592 | .95 | 500. |
| .59759 | 2.07349 | 4995. | .05093 | 9.86 | 500. |
| .60237 | 2.07533 | 21000. | .01945 | .11 | 500. |
| .59837 | 2.07026 | 7004. | .06225 | 9.46 | 500. |
| .59481 | 2.06520 | 3800. | .07852 | 25.84 | 500. |
| .60196 | 2.06948 | 24000. | .04562 | 1.53 | 500. |
| .60008 | 2.05780 | 23994. | .95013 | 1.66 | 500. |
| .59825 | 2.05440 | 6236. | .06549 | 15.44 | 500. |
| .59810 | 2.05408 | 689. | .05720 | 10.95 | 500. |
| .60105 | 2.06448 | 3994. | .04951 | 15.63 | 500. |
| .60122 | 2.05308 | 10498. | .04244 | 5.72 | 500. |

TABLE C-6

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59329 | 2.05173 | 1255. | .00347 | 3.85 | 125. |
| .60665 | 2.05881 | 28719. | .01556 | .36 | 500. |
| .60129 | 2.05454 | 5922. | .01945 | .96 | 500. |
| .59220 | 2.05027 | 2991. | .07922 | 4.72 | 125. |
| .59720 | 2.05280 | 2500. | .01495 | 2.04 | 500. |
| .59541 | 2.05044 | 7500. | .00355 | 1.63 | 500. |
| .59255 | 2.05429 | 1621. | .04203 | 4.76 | 500. |
| .59382 | 2.05606 | 3403. | .05836 | 6.69 | 500. |
| .59343 | 2.05645 | 3401. | .06225 | 3.06 | 125. |
| .59005 | 2.06067 | 1998. | .08099 | 9.21 | 125. |
| .58621 | 2.05547 | 10992. | .05093 | 1.34 | 500. |
| .58928 | 2.06058 | 1097. | .07675 | 10.19 | 125. |
| .58773 | 2.05855 | 1693. | .07177 | 7.41 | 125. |
| .58818 | 2.06035 | 1692. | .07746 | 10.24 | 125. |
| .58253 | 2.05610 | 5492. | .04527 | 4.77 | 500. |
| .58246 | 2.05667 | 4498. | .04845 | 6.22 | 500. |
| .58808 | 2.06053 | 1997. | .07719 | 11.37 | 125. |
| .58398 | 2.05805 | 4513. | .05820 | 9.07 | 500. |
| .58778 | 2.06048 | 1825. | .07675 | 10.28 | 125. |
| .58537 | 2.05941 | 3503. | .06519 | 4.35 | 125. |
| .58957 | 2.06168 | 1494. | .08311 | 9.47 | 125. |
| .58720 | 2.06096 | 0. | .07816 | 9.34 | 125. |
| .58138 | 2.05949 | 10594. | .05193 | 2.10 | 500. |
| .58674 | 2.05119 | 10494. | .07781 | 5.77 | 500. |
| .58437 | 2.06387 | 18320. | .06529 | .51 | 500. |
| .58433 | 2.06116 | 2470. | .05566 | 13.80 | 500. |
| .58833 | 2.06193 | 4500. | .07922 | 12.27 | 125. |
| .58229 | 2.05207 | 1994. | .05517 | 8.92 | 500. |
| .57477 | 2.05323 | 4906. | .01453 | .53 | 500. |
| .58667 | 2.06254 | 1451. | .07322 | 6.48 | 125. |
| .58518 | 2.06284 | 9900. | .07498 | 6.60 | 500. |
| .57972 | 2.06563 | 2503. | .03784 | 5.83 | 500. |
| .57905 | 2.05616 | 5500. | .03325 | 6.03 | 500. |
| .58119 | 2.05592 | 2156. | .04559 | 7.06 | 500. |
| .58157 | 2.06554 | 1268. | .04881 | 7.42 | 500. |
| .58169 | 2.06618 | 704. | .04845 | 6.73 | 500. |
| .58688 | 2.05375 | 6495. | .08064 | 6.50 | 125. |
| .57821 | 2.06914 | 24486. | .02015 | .01 | 500. |
| .58572 | 2.06465 | 7491. | .07675 | 10.18 | 500. |
| .58614 | 2.05847 | 7539. | .07392 | 5.04 | 500. |
| .58873 | 2.05555 | 4203. | .08418 | 5.08 | 125. |
| .59020 | 2.05580 | 3876. | .08630 | 7.31 | 125. |
| .59033 | 2.06907 | 6900. | .07816 | 14.67 | 500. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59032 | 2.06567 | 8500. | .08559 | 10.63 | 500. |
| .59202 | 2.08046 | 2500. | .01698 | 2.46 | 500. |
| .59210 | 2.07871 | 15000. | .01874 | .12 | 500. |
| .59358 | 2.08122 | 2658. | .01450 | 2.53 | 500. |
| .59205 | 2.07040 | 7010. | .06755 | 8.00 | 500. |
| .59402 | 2.07891 | 4502. | .01910 | 5.76 | 500. |
| .59338 | 2.07475 | 4603. | .03466 | 10.40 | 500. |
| .59155 | 2.06592 | 1344. | .08630 | 6.97 | 125. |
| .59568 | 2.07684 | 3098. | .02971 | 5.73 | 500. |
| .59237 | 2.06749 | 1289. | .08099 | 5.26 | 125. |
| .59260 | 2.06792 | 1066. | .07922 | 5.13 | 125. |
| .59234 | 2.06710 | 656. | .08276 | 5.26 | 125. |
| .59591 | 2.07604 | 8502. | .03218 | 5.65 | 500. |
| .59920 | 2.08409 | 9500. | .00894 | .19 | 500. |
| .59374 | 2.07031 | 3555. | .06851 | 6.17 | 125. |
| .59452 | 2.07057 | 8495. | .06578 | 9.27 | 500. |
| .59705 | 2.07550 | 4007. | .03658 | 6.05 | 500. |
| .59486 | 2.07086 | 4996. | .05366 | 3.59 | 125. |
| .59525 | 2.07815 | 11002. | .02582 | .76 | 500. |
| .59759 | 2.07349 | 4995. | .05093 | 2.00 | 125. |
| .60237 | 2.07633 | 21000. | .01945 | .09 | 500. |
| .59334 | 2.06546 | 8500. | .08418 | 11.03 | 500. |
| .59837 | 2.07026 | 7004. | .06225 | 9.49 | 500. |
| .60380 | 2.07349 | 6500. | .02723 | 1.36 | 500. |
| .59446 | 2.06536 | 2593. | .08064 | 4.23 | 125. |
| .59481 | 2.06520 | 3800. | .07852 | 6.26 | 125. |
| .60196 | 2.06948 | 24000. | .04552 | 1.53 | 500. |
| .60008 | 2.06780 | 23994. | .05013 | 1.38 | 500. |
| .59817 | 2.06577 | 3493. | .06649 | 6.70 | 125. |
| .60032 | 2.06663 | 6455. | .05694 | 4.56 | 125. |
| .60015 | 2.06606 | 4541. | .05836 | 6.38 | 125. |
| .59794 | 2.06469 | 1017. | .06755 | 4.30 | 125. |
| .59825 | 2.06440 | 6236. | .05549 | 5.34 | 125. |
| .59810 | 2.06408 | 689. | .05723 | 11.24 | 500. |
| .60362 | 2.06544 | 3007. | .03183 | 7.97 | 500. |
| .60112 | 2.06458 | 2303. | .04881 | 4.39 | 125. |
| .60105 | 2.06448 | 3994. | .04951 | 4.84 | 125. |
| .60424 | 2.05486 | 1341. | .03183 | 5.46 | 500. |
| .59798 | 2.06350 | 5830. | .05549 | 5.99 | 125. |
| .60359 | 2.06461 | 5494. | .03219 | 6.27 | 500. |
| .59576 | 2.06252 | 4497. | .07575 | 5.44 | 125. |
| .59896 | 2.05335 | 8500. | .05295 | 9.64 | 500. |
| .59447 | 2.06241 | 7500. | .07816 | 3.28 | 125. |
| .60122 | 2.06338 | 15498. | .04244 | 5.60 | 500. |

TABLE C-7

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59329 | 2.06173 | 1255. | .08347 | 15.76 | 500. |
| .60665 | 2.03881 | 28719. | .01556 | .30 | 500. |
| .60129 | 2.05454 | 5922. | .01345 | 1.31 | 500. |
| .55220 | 2.05027 | 2951. | .07922 | 17.98 | 500. |
| .55720 | 2.05280 | 2500. | .01435 | 2.14 | 500. |
| .55341 | 2.03044 | 7500. | .00955 | 1.61 | 500. |
| .59255 | 2.05425 | 1621. | .04259 | 4.76 | 500. |
| .55082 | 2.03605 | 3405. | .05836 | 7.12 | 500. |
| .55043 | 2.05645 | 3401. | .05225 | 12.71 | 500. |
| .59005 | 2.05067 | 1998. | .08099 | 20.04 | 500. |
| .58621 | 2.05547 | 10992. | .05093 | 1.29 | 500. |
| .58928 | 2.05058 | 1097. | .07675 | 16.83 | 500. |
| .58773 | 2.05865 | 1593. | .07103 | 17.02 | 500. |
| .58818 | 2.06005 | 1692. | .07746 | 16.34 | 500. |
| .58253 | 2.03610 | 3492. | .04527 | 4.99 | 500. |
| .58245 | 2.05657 | 6498. | .04845 | 6.18 | 500. |
| .58808 | 2.06053 | 1397. | .07713 | 15.14 | 500. |
| .58398 | 2.05805 | 4513. | .05890 | 8.87 | 500. |
| .58778 | 2.05048 | 1225. | .07577 | 16.45 | 500. |
| .58537 | 2.05941 | 3703. | .06614 | 15.38 | 500. |
| .58967 | 2.06168 | 1494. | .03311 | 21.66 | 500. |
| .58726 | 2.05856 | 0. | .07816 | 15.97 | 500. |
| .58198 | 2.05949 | 10994. | .05199 | 2.12 | 500. |
| .58674 | 2.06119 | 10494. | .07781 | 5.85 | 500. |
| .58467 | 2.05087 | 14320. | .06559 | .51 | 500. |
| .58433 | 2.06116 | 2470. | .06366 | 12.77 | 500. |
| .58833 | 2.05193 | 4500. | .17922 | 24.80 | 500. |
| .58229 | 2.06207 | 1994. | .05517 | 9.09 | 500. |
| .57477 | 2.06323 | 4006. | .01450 | .36 | 500. |
| .58667 | 2.06254 | 1451. | .07922 | 18.41 | 500. |
| .58518 | 2.06284 | 9509. | .07498 | 7.25 | 500. |
| .57972 | 2.06563 | 2500. | .03784 | 6.01 | 500. |
| .57905 | 2.06615 | 5500. | .03325 | 5.62 | 500. |
| .58119 | 2.06592 | 2166. | .04659 | 7.25 | 500. |
| .58157 | 2.06594 | 1268. | .04891 | 7.51 | 500. |
| .58169 | 2.06618 | 704. | .04845 | 7.15 | 500. |
| .58688 | 2.06375 | 6495. | .08034 | 15.63 | 500. |
| .57821 | 2.06914 | 24486. | .02316 | .01 | 500. |
| .58572 | 2.06465 | 7491. | .07675 | 11.37 | 500. |
| .58614 | 2.06847 | 7539. | .07392 | 5.44 | 500. |
| .58873 | 2.06555 | 4203. | .08418 | 20.33 | 500. |
| .55020 | 2.06580 | 3876. | .08639 | 19.65 | 500. |
| .59933 | 2.06907 | 6000. | .07816 | 14.58 | 500. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .55032 | 2.06567 | 8500. | .08559 | 10.71 | 500. |
| .55202 | 2.08046 | 2500. | .01678 | 2.57 | 500. |
| .59210 | 2.07871 | 10000. | .01874 | .10 | 500. |
| .59358 | 2.08122 | 2698. | .01459 | 2.53 | 500. |
| .59205 | 2.07040 | 7010. | .06755 | 7.80 | 500. |
| .59402 | 2.07891 | 4502. | .01910 | 6.17 | 500. |
| .59338 | 2.07475 | 4503. | .03465 | 9.82 | 500. |
| .59155 | 2.06592 | 1344. | .08630 | 14.78 | 500. |
| .59568 | 2.07684 | 3068. | .02971 | 5.74 | 500. |
| .59237 | 2.05740 | 1289. | .08099 | 13.27 | 500. |
| .59260 | 2.05792 | 1066. | .07922 | 14.18 | 500. |
| .59234 | 2.05710 | 654. | .08275 | 11.51 | 500. |
| .59591 | 2.07604 | 8500. | .03219 | 5.30 | 500. |
| .59920 | 2.08409 | 9500. | .00844 | .18 | 500. |
| .59374 | 2.07031 | 3655. | .05891 | 14.88 | 500. |
| .59452 | 2.07057 | 8495. | .06578 | 8.96 | 500. |
| .59705 | 2.07553 | 4007. | .03678 | 5.75 | 500. |
| .59486 | 2.07085 | 4994. | .05355 | 14.55 | 500. |
| .59925 | 2.07815 | 11002. | .02582 | .83 | 500. |
| .59759 | 2.07349 | 4995. | .05393 | 9.36 | 500. |
| .60237 | 2.07633 | 21000. | .01945 | .14 | 500. |
| .59334 | 2.06546 | 8500. | .08418 | 12.01 | 500. |
| .59837 | 2.07026 | 7094. | .06225 | 9.56 | 500. |
| .60306 | 2.07349 | 6500. | .02723 | 1.39 | 500. |
| .59446 | 2.06536 | 2593. | .08054 | 18.09 | 500. |
| .59481 | 2.06529 | 3800. | .07952 | 25.38 | 500. |
| .60196 | 2.06948 | 24000. | .04559 | 1.52 | 500. |
| .60008 | 2.05780 | 23994. | .05013 | 1.41 | 500. |
| .59817 | 2.05577 | 3493. | .05649 | 16.93 | 500. |
| .60032 | 2.06663 | 6495. | .05674 | 14.99 | 500. |
| .60019 | 2.06605 | 4541. | .03836 | 14.87 | 500. |
| .59794 | 2.06469 | 1017. | .06755 | 13.36 | 500. |
| .59825 | 2.05449 | 6236. | .06443 | 15.81 | 500. |
| .59810 | 2.05408 | 689. | .06721 | 11.99 | 500. |
| .60363 | 2.05544 | 3907. | .03183 | 7.58 | 500. |
| .60112 | 2.06450 | 2303. | .04881 | 14.01 | 500. |
| .60105 | 2.06448 | 3994. | .04931 | 16.46 | 500. |
| .60424 | 2.06486 | 1341. | .03183 | 5.03 | 500. |
| .59798 | 2.06359 | 5830. | .06549 | 18.55 | 500. |
| .60369 | 2.06461 | 5494. | .03218 | 5.46 | 500. |
| .59576 | 2.06292 | 4497. | .07675 | 18.56 | 500. |
| .59896 | 2.06335 | 8500. | .06295 | 10.13 | 500. |
| .59447 | 2.06241 | 7500. | .07816 | 11.77 | 500. |
| .60122 | 2.06308 | 10498. | .04243 | 5.75 | 500. |

TABLE C-8

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59329 | 2.06173 | 1255. | .08347 | 17.39 | 31. |
| .60555 | 2.03881 | 28719. | .01555 | .31 | 500. |
| .60129 | 2.05454 | 5922. | .01995 | 3.83 | 500. |
| .59220 | 2.06027 | 2991. | .07922 | 20.88 | 125. |
| .59720 | 2.05280 | 2500. | .01435 | 5.59 | 500. |
| .55541 | 2.05044 | 7500. | .00955 | 3.79 | 500. |
| .59255 | 2.05425 | 1621. | .04219 | 9.35 | 500. |
| .59082 | 2.05606 | 3405. | .05836 | 3.75 | 125. |
| .59043 | 2.05645 | 3401. | .06225 | 4.20 | 125. |
| .55005 | 2.06067 | 1938. | .08039 | 18.83 | 31. |
| .58621 | 2.05547 | 10992. | .05073 | 2.74 | 500. |
| .58928 | 2.06058 | 1097. | .07675 | 20.43 | 31. |
| .58773 | 2.05865 | 1693. | .07109 | 17.09 | 125. |
| .58818 | 2.06005 | 1692. | .07745 | 16.87 | 31. |
| .58253 | 2.05610 | 5492. | .04527 | 12.40 | 500. |
| .58246 | 2.05667 | 6498. | .04895 | 15.40 | 500. |
| .58808 | 2.06055 | 1997. | .07710 | 19.44 | 31. |
| .58398 | 2.05805 | 4513. | .05800 | 11.01 | 125. |
| .58778 | 2.06048 | 1225. | .07675 | 21.08 | 31. |
| .58337 | 2.05941 | 3003. | .06519 | 17.33 | 125. |
| .58967 | 2.06168 | 1494. | .08311 | 24.97 | 31. |
| .58720 | 2.05095 | 0. | .07815 | 21.57 | 31. |
| .58198 | 2.05949 | 10994. | .05199 | 3.50 | 500. |
| .58674 | 2.06119 | 10494. | .07781 | 9.65 | 500. |
| .58467 | 2.06087 | 18320. | .05508 | .51 | 500. |
| .58433 | 2.06116 | 2470. | .05555 | 17.48 | 125. |
| .58833 | 2.06193 | 4500. | .07922 | 24.38 | 31. |
| .58229 | 2.06207 | 1994. | .05517 | 8.74 | 125. |
| .57477 | 2.06323 | 4706. | .01430 | 1.40 | 500. |
| .58667 | 2.06254 | 1451. | .07922 | 19.34 | 31. |
| .58518 | 2.06284 | 9500. | .07478 | 12.59 | 500. |
| .57972 | 2.06563 | 2503. | .03784 | 7.27 | 125. |
| .57905 | 2.06616 | 3500. | .03325 | 14.49 | 500. |
| .58119 | 2.06592 | 2166. | .04559 | 12.01 | 125. |
| .58137 | 2.06599 | 1268. | .04881 | 12.55 | 125. |
| .58169 | 2.06618 | 704. | .04945 | 12.09 | 125. |
| .58688 | 2.06375 | 5495. | .08064 | 21.68 | 125. |
| .57821 | 2.05911 | 24986. | .02315 | .01 | 500. |
| .58572 | 2.06465 | 7491. | .07675 | 9.44 | 125. |
| .58614 | 2.06847 | 7539. | .07332 | 11.46 | 500. |
| .58873 | 2.05555 | 4203. | .08413 | 12.28 | 31. |
| .59020 | 2.05580 | 3875. | .08531 | 12.06 | 31. |
| .55033 | 2.06907 | 6303. | .07815 | [illegible] | 125. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59032 | 2.08561 | 8500. | .08333 | 8.34 | 125. |
| .59202 | 2.08046 | 2500. | .01598 | 4.19 | 500. |
| .59210 | 2.07871 | 15000. | .01874 | .09 | 500. |
| .55358 | 2.08122 | 2698. | .01459 | 4.20 | 500. |
| .59205 | 2.07040 | 7010. | .06755 | 7.49 | 125. |
| .59402 | 2.07891 | 4502. | .01919 | 9.67 | 500. |
| .59338 | 2.07475 | 4603. | .03456 | 5.57 | 125. |
| .59155 | 2.05592 | 1344. | .08630 | 19.83 | 125. |
| .55568 | 2.07684 | 3108. | .02971 | 12.88 | 500. |
| .59237 | 2.06749 | 1289. | .08199 | 17.41 | 125. |
| .59260 | 2.06792 | 1066. | .07922 | 15.38 | 125. |
| .55234 | 2.06710 | 656. | .08276 | 17.52 | 125. |
| .55591 | 2.07604 | 6502. | .03218 | 9.30 | 500. |
| .59920 | 2.08409 | 9500. | .00884 | .24 | 500. |
| .59374 | 2.07031 | 3655. | .06851 | 12.39 | 125. |
| .59453 | 2.07057 | 8495. | .05579 | 5.76 | 125. |
| .55705 | 2.07550 | 4007. | .03618 | 4.00 | 125. |
| .59486 | 2.07086 | 1996. | .06365 | 10.98 | 125. |
| .59925 | 2.07815 | 11002. | .02582 | .99 | 500. |
| .59755 | 2.07349 | 4995. | .05093 | 4.48 | 125. |
| .60237 | 2.07633 | 21000. | .01945 | .16 | 500. |
| .59334 | 2.05546 | 8500. | .08418 | 7.00 | 125. |
| .55837 | 2.07025 | 7004. | .06225 | 3.73 | 125. |
| .60380 | 2.07349 | 6500. | .02723 | 6.36 | 500. |
| .59446 | 2.06536 | 2593. | .08054 | 13.04 | 125. |
| .59481 | 2.05520 | 3800. | .07852 | 15.73 | 125. |
| .60196 | 2.06948 | 24000. | .04562 | 1.43 | 500. |
| .60008 | 2.05789 | 23999. | .05013 | 1.34 | 500. |
| .59817 | 2.06577 | 3493. | .05649 | 15.54 | 125. |
| .60032 | 2.05563 | 6495. | .05524 | 10.85 | 125. |
| .60019 | 2.06536 | 4541. | .05936 | 12.33 | 125. |
| .59794 | 2.06469 | 1017. | .06755 | 11.12 | 125. |
| .59825 | 2.05440 | 6236. | .05649 | 11.23 | 125. |
| .55810 | 2.06408 | 589. | .06720 | 8.47 | 125. |
| .60363 | 2.06544 | 3007. | .03183 | 9.25 | 125. |
| .60112 | 2.05458 | 2303. | .04831 | 10.30 | 125. |
| .60105 | 2.06448 | 3994. | .04951 | 10.50 | 125. |
| .60424 | 2.05486 | 1341. | .03193 | 10.26 | 125. |
| .59798 | 2.06330 | 5830. | .06649 | 11.80 | 125. |
| .60369 | 2.06451 | 5494. | .03219 | 9.50 | 125. |
| .59576 | 2.06292 | 4497. | .07675 | 13.72 | 125. |
| .59856 | 2.06335 | 8500. | .06233 | 7.42 | 125. |
| .59447 | 2.05241 | 7500. | .07815 | 11.28 | 125. |
| .60122 | 2.05308 | 10498. | .04244 | 6.20 | 500. |

TABLE C-9

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59329 | 2.06173 | 1255. | .08347 | 50.04 | 500. |
| .60665 | 2.05881 | 28719. | .01556 | .38 | 500. |
| .60129 | 2.05454 | 5922. | .01945 | 3.66 | 500. |
| .59220 | 2.06027 | 2991. | .07922 | 51.02 | 500. |
| .59720 | 2.05280 | 2500. | .01465 | 5.71 | 500. |
| .59541 | 2.05044 | 7500. | .00955 | 3.85 | 500. |
| .59255 | 2.05425 | 1621. | .04209 | 10.04 | 500. |
| .59082 | 2.05606 | 3405. | .05836 | 14.74 | 500. |
| .59043 | 2.05645 | 3401. | .06225 | 26.46 | 500. |
| .59005 | 2.06067 | 1998. | .08099 | 62.71 | 500. |
| .58621 | 2.05547 | 10992. | .05093 | 2.89 | 500. |
| .58928 | 2.06058 | 1097. | .07675 | 61.87 | 500. |
| .58773 | 2.05865 | 1693. | .07109 | 47.55 | 500. |
| .58818 | 2.06005 | 1692. | .07746 | 65.13 | 500. |
| .58253 | 2.05610 | 5492. | .04527 | 12.41 | 500. |
| .58246 | 2.05667 | 6498. | .04845 | 16.01 | 500. |
| .58808 | 2.06053 | 1997. | .07710 | 63.53 | 500. |
| .58398 | 2.05805 | 4513. | .05800 | 28.39 | 500. |
| .58778 | 2.06046 | 1225. | .07675 | 56.89 | 500. |
| .58537 | 2.05941 | 3003. | .06614 | 44.10 | 500. |
| .58967 | 2.06168 | 1494. | .08311 | 65.55 | 500. |
| .58720 | 2.06096 | 0. | .07816 | 53.62 | 500. |
| .58198 | 2.05949 | 10994. | .05199 | 3.82 | 500. |
| .58674 | 2.06119 | 10494. | .07781 | 9.93 | 500. |
| .58467 | 2.06087 | 18320. | .06508 | .51 | 500. |
| .58433 | 2.06116 | 2470. | .06366 | 45.62 | 500. |
| .58833 | 2.06193 | 4500. | .07922 | 79.07 | 500. |
| .58229 | 2.06207 | 1994. | .05517 | 35.02 | 500. |
| .57477 | 2.06323 | 4006. | .01450 | 1.42 | 500. |
| .58667 | 2.06254 | 1451. | .07922 | 63.54 | 500. |
| .58518 | 2.06284 | 9500. | .07498 | 12.58 | 500. |
| .57972 | 2.06563 | 2503. | .03784 | 19.21 | 500. |
| .57905 | 2.06616 | 5500. | .03325 | 14.16 | 500. |
| .58119 | 2.06592 | 2166. | .04669 | 23.29 | 500. |
| .58157 | 2.06594 | 1268. | .04881 | 26.16 | 500. |
| .58169 | 2.06618 | 704. | .04845 | 25.98 | 500. |
| .58688 | 2.06375 | 6495. | .08064 | 55.93 | 500. |
| .57821 | 2.06914 | 24486. | .02016 | .01 | 500. |
| .58572 | 2.06465 | 7491. | .07675 | 34.66 | 500. |
| .58614 | 2.06847 | 7539. | .07392 | 11.59 | 500. |
| .58873 | 2.06555 | 4203. | .08418 | 62.76 | 500. |
| .59020 | 2.06580 | 3876. | .08630 | 62.01 | 500. |
| .59033 | 2.06907 | 6000. | .07816 | 31.97 | 500. |

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .59032 | 2.06567 | 8500. | .08559 | 23.06 | 500. |
| .59202 | 2.08046 | 2500. | .01698 | 4.51 | 500. |
| .59210 | 2.07871 | 16000. | .01874 | .11 | 500. |
| .59358 | 2.08122 | 2698. | .01450 | 4.23 | 500. |
| .59205 | 2.07040 | 7010. | .06755 | 23.43 | 500. |
| .59402 | 2.07891 | 4502. | .01910 | 9.44 | 500. |
| .59338 | 2.07475 | 4603. | .03466 | 21.52 | 500. |
| .59155 | 2.06592 | 1344. | .08630 | 61.75 | 500. |
| .59568 | 2.07684 | 3008. | .02971 | 12.85 | 500. |
| .59237 | 2.06740 | 1289. | .08099 | 42.21 | 500. |
| .59260 | 2.06792 | 1066. | .07922 | 38.96 | 500. |
| .59234 | 2.06710 | 656. | .08276 | 43.66 | 500. |
| .59591 | 2.07604 | 8502. | .03218 | 9.15 | 500. |
| .59920 | 2.08409 | 9500. | .00884 | .31 | 500. |
| .59374 | 2.07031 | 3655. | .06861 | 37.74 | 500. |
| .59453 | 2.07057 | 8495. | .06578 | 16.71 | 500. |
| .59705 | 2.07550 | 4007. | .03608 | 14.39 | 500. |
| .59486 | 2.07086 | 4996. | .06366 | 37.04 | 500. |
| .59925 | 2.07815 | 11002. | .02582 | 1.24 | 500. |
| .59759 | 2.07349 | 4995. | .05093 | 16.24 | 500. |
| .60237 | 2.07633 | 21000. | .01945 | .09 | 500. |
| .59334 | 2.06546 | 8500. | .08418 | 23.95 | 500. |
| .59837 | 2.07026 | 7004. | .06225 | 19.22 | 500. |
| .60380 | 2.07349 | 6500. | .02723 | 6.44 | 500. |
| .59446 | 2.06536 | 2593. | .08064 | 57.11 | 500. |
| .59481 | 2.06520 | 3800. | .07852 | 66.13 | 500. |
| .60196 | 2.06948 | 24000. | .04562 | 1.62 | 500. |
| .60008 | 2.06780 | 23994. | .06013 | 1.45 | 500. |
| .59817 | 2.06577 | 3493. | .06649 | 35.24 | 500. |
| .60032 | 2.06663 | 6495. | .05694 | 29.35 | 500. |
| .60019 | 2.06606 | 4541. | .05836 | 32.26 | 500. |
| .59794 | 2.06469 | 1017. | .06755 | 32.63 | 500. |
| .59825 | 2.06440 | 6236. | .06649 | 32.41 | 500. |
| .59810 | 2.06408 | 689. | .06720 | 28.81 | 500. |
| .60363 | 2.06544 | 3007. | .03183 | 22.82 | 500. |
| .60112 | 2.06458 | 2303. | .04881 | 35.45 | 500. |
| .60105 | 2.06448 | 3994. | .04951 | 36.79 | 500. |
| .60424 | 2.06486 | 1341. | .03183 | 17.92 | 500. |
| .59798 | 2.06350 | 5830. | .06649 | 37.80 | 500. |
| .60369 | 2.06461 | 5494. | .03218 | 21.25 | 500. |
| .59576 | 2.06292 | 4497. | .07675 | 44.79 | 500. |
| .59896 | 2.06335 | 8500. | .06295 | 19.83 | 500. |
| .59447 | 2.06241 | 7500. | .07816 | 25.60 | 500. |
| .60122 | 2.06308 | 10498. | .04244 | 6.18 | 500. |

TABLE C-10

| | | | | | |
|---|---|---|---|---|---|
| ~~.60665~~ | ~~2.05881~~ | ~~28719.~~ | ~~.00929~~ | ~~.29~~ | ~~500.~~ |
| .58621 | 2.05547 | 10992. | .02723 | .63 | 500. |
| .58198 | 2.05949 | 10994. | .02723 | 1.25 | 500. |
| ~~.58467~~ | ~~2.06087~~ | ~~18320.~~ | ~~.03431~~ | ~~.51~~ | ~~500.~~ |
| .58433 | 2.06116 | 2470. | .03431 | 5.70 | 500. |
| .57477 | 2.06323 | 4006. | .00849 | .24 | 500. |
| ~~.58157~~ | ~~2.06594~~ | ~~1268.~~ | ~~.02546~~ | ~~4.31~~ | ~~500.~~ |
| .57821 | 2.06914 | 24486. | .01026 | .01 | 500. |
| .58873 | 2.06555 | 4203. | .04173 | 8.24 | 500. |
| ~~.59033~~ | ~~2.06907~~ | ~~6500.~~ | ~~.03855~~ | ~~6.67~~ | ~~500.~~ |
| .55202 | 2.08046 | 2500. | .00743 | 1.33 | 500. |
| .59155 | 2.06592 | 1344. | .04138 | 8.14 | 500. |
| ~~.55568~~ | ~~2.07684~~ | ~~3008.~~ | ~~.01415~~ | ~~4.75~~ | ~~500.~~ |
| .55237 | 2.06740 | 1289. | .03961 | 7.14 | 500. |
| .55591 | 2.07604 | 8502. | .01521 | 4.62 | 500. |
| ~~.59920~~ | ~~2.08409~~ | ~~9500.~~ | ~~.00531~~ | ~~.12~~ | ~~500.~~ |
| .55755 | 2.07349 | 4995. | .02405 | 5.86 | 500. |
| .60237 | 2.07633 | 21000. | .00990 | .05 | 500. |
| ~~.59837~~ | ~~2.07026~~ | ~~7004.~~ | ~~.03006~~ | ~~4.34~~ | ~~500.~~ |
| .59481 | 2.06520 | 3800. | .03890 | 9.96 | 500. |
| .60196 | 2.06948 | 24000. | .02122 | .32 | 500. |
| ~~.60105~~ | ~~2.06448~~ | ~~3994.~~ | ~~.02449~~ | ~~7.30~~ | ~~500.~~ |
| .60122 | 2.06308 | 10498. | .02122 | 2.62 | 500. |

TABLE C-11

| LAT | LON | ALT | LOCAL DENSITY | INT RATE | PWR |
|---|---|---|---|---|---|
| .58621 | 2.05547 | 10992. | .01238 | .35 | 500. |
| .58198 | 2.05949 | 10994. | .01203 | .07 | 500. |
| .58467 | 2.06087 | 18320. | .01485 | .51 | 500. |
| .59433 | 2.06116 | 2470. | .01485 | .80 | 500. |
| .57477 | 2.06323 | 4006. | .00354 | .05 | 500. |
| .58157 | 2.06594 | 1268. | .01167 | .11 | 500. |
| .57821 | 2.06914 | 24486. | .00424 | .01 | 500. |
| .59033 | 2.06907 | 6000. | .01804 | .81 | 500. |
| .59759 | 2.07349 | 4995. | .01152 | .55 | 500. |
| .60237 | 2.07533 | 21000. | .00435 | .05 | 500. |
| .60196 | 2.06948 | 24000. | .01026 | .30 | 500. |
| .60122 | 2.06308 | 10498. | .01203 | 1.35 | 500. |

# APPENDIX D

# MODEL DESCRIPTION

## GENERAL

The computerized model used to simulate TCAS operation in the DABS/ATCRBS environment consists of a statistical TCAS submodel merged with the deterministic ECAC DABS/ATCRBS/AIMS Performance Prediction Model (PPM).[a] The model is coded in FORTRAN V and its predictions are computed using a Univac 1110 computer at ECAC. The DABS/ATCRBS/AIMS PPM consists of a number of subroutines that simulate the operation of DABS and ATCRBS sensors and transponders. The performance of an interrogator of interest ($I_o$) is predicted based on computed transponder reply records, fruit rates, and target-detection/code-validation data tabulated during one complete revolution of the $I_o$ mainbeam.

The TCAS routine models the operation of all the airborne TCAS interrogators in the environment. It generates average rates at which TCAS emissions (DABS interrogations, ATCRBS interrogations, and suppressions) arrive at each airborne transponder. These TCAS signals are then merged with the signal environment generated by the ground-system interrogators to predict transponder and interrogator performance.

The combined model simulates TCAS operation (both with and without interference-limiting) to evaluate the impact of TCAS on ground-system performance. A more detailed description of the TCAS routine and the DABS/ATCRBS PPM follows.

---

[a] The merging of the statistical TCAS submodel with the deterministic DABS/ATCRBS/AIMS PPM is explained later.

## DABS/ATCRBS/AIMS PPM

The DABS/ATCRBS/AIMS PPM is the basis for the TCAS modeling and analysis effort. The PPM was originally developed as part of the DABS Spectrum Management Program to provide air-traffic-control performance prediction capability in future environments where ATCRBS and the proposed DABS will coexist.

The DABS/ATCRBS/AIMS PPM is a time-event-store computer algorithm that uses the known deployed equipment locations and characteristics (ATCRBS interrogators, DABS sensors, and airborne transponders) to simulate air-traffic-control operations, and to evaluate system performance. The model consists of a number of subroutines that are discussed below. The standard input characteristics consist of the two basic categories listed in TABLE D-1.

TABLE D-1

DABS/ATCRBS/AIMS PPM INPUTS

| Sensor/Interrogator Environment | Transponder Environment |
|---|---|
| Latitude | Latitude |
| Longitude | Longitude |
| Site Elevation/Antenna Height | Altitude |
| Output Power | Output Power |
| Receiver Sensitivity | Receiver Sensitivity |
| Sidelobe Supression Type | Mode Capability |
| Pulse Repetition Frequency | Antenna Type |
| Mode Interlace | |
| Antenna | |
| Mainbeam Gain/Width | |
| Sidelobe Gain/Width | |
| Backlobe Gain/Width | |
| Scan Rate | |

## DABS/ATCRBS/AIMS ALGORITHMS

### Input

The simulation cycle for the DABS/ATCRBS/AIMS PPM is one pulse-repetition period (PRP) of the interrogator-of-interest, $I_o$. For DABS sensors, one PRP is defined as the time between transmissions of all-call interrogations. A flow diagram of the DABS/ATCRBS/AIMS PPM is shown in Figure D-1. Subroutine INPUT, shown in the figure, performs the basic functions of compiling input data, performing the interrogator-file radius cull, and ordering of the environmental data into the appropriate arrays for efficient access by later routines.

### Channel Management

The main loop of program execution begins in subroutine ACTIVE. In ACTIVE, all DABS sensors search their active target list to determine which targets, based on last reported range and azimuth, are expected to be in the mainbeam during the present simulation cycle. The active target list is constructed for all DABS sensors in the simulated environment. The target-list update is based on the results of past discretely addressed transactions attempted with DABS-equipped aircraft.

### DABS Scheduling

After completing the channel management portion of the program in subroutine ACTIVE, program control is passed to subroutine ROLCAL. ROLCAL establishes the all-call and roll-call interrogation times for the present simulation cycle. Roll-call transactions are scheduled to the appropriate targets in decreasing range order and are spaced so as to avoid a) synchronous garble and b) overlapping of the transmitted and received signals.

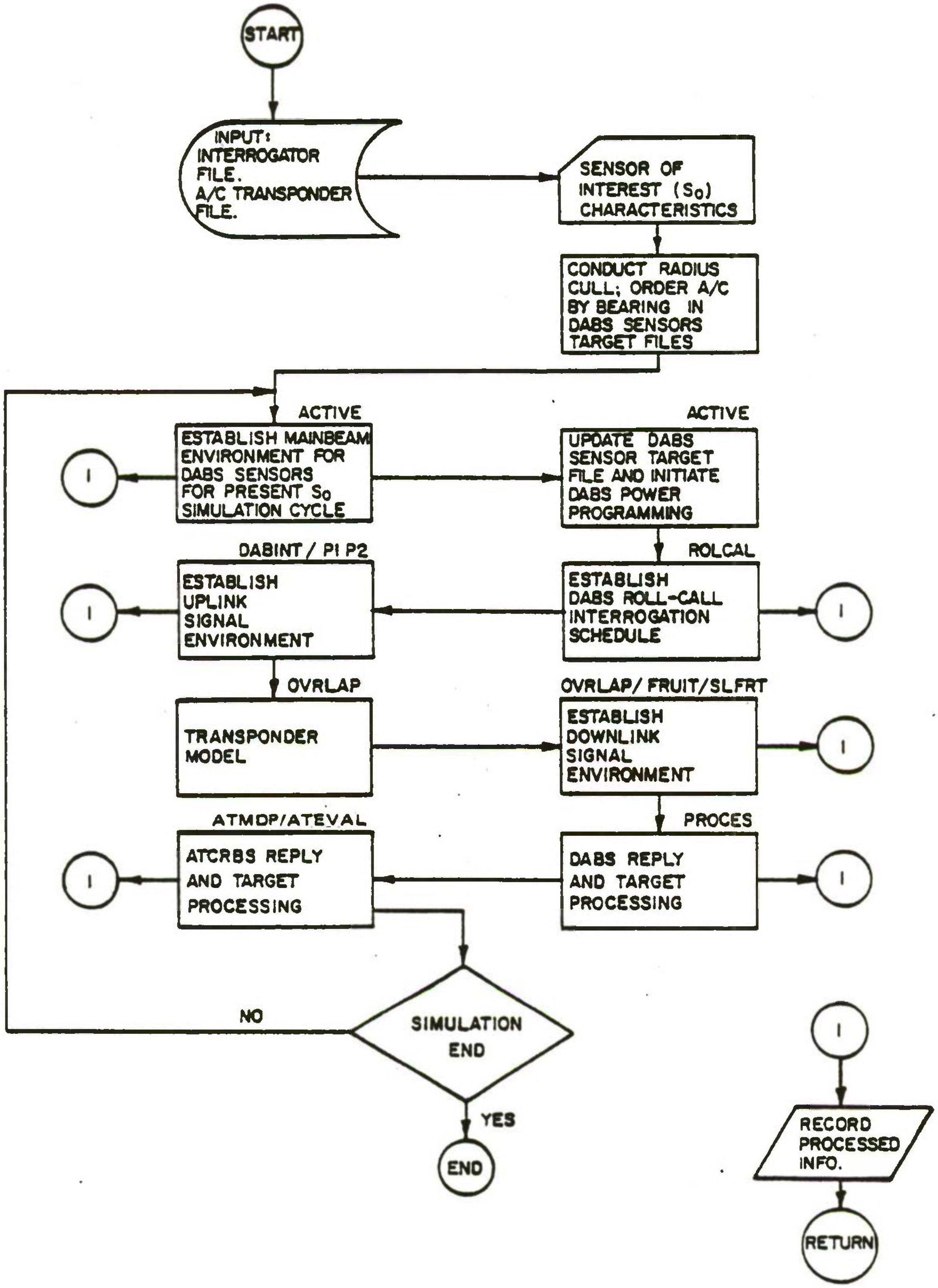


Figure D-1. Flow chart of DABS PPM major submodel functions.

Uplink Power Cull

The arrival times of all interferring interrogations and suppressions from all ground sensors at each DABS- or ATCRBS-equipped aircraft in the $I_o$ mainbeam are established in subroutines DABINT and P1-P2.[a] First, the coupling between each ground sensor and each $I_o$ mainbeam A/C is determined, based on the sensor rotation rate and the elapsed time from the last simulation cycle. Subroutine PLOSS is accessed to calculate the received signal strength at the transponder, based on free-space path loss plus over-the-horizon attenuation, sensor output power, cabling losses, and sensor and aircraft antenna gains. If the signal level is greater than the transponder sensitivity, the interrogation time or sidelobe suppression time is stored in the appropriate array.

Transponder Models

Subroutine OVRLAP simulates the operation of the transponder. For either a DABS- or ATCRBS-equipped aircraft, the arrival time of the $I_o$ interrogation is compared with the arrival times of each type of interfering signal (other interrogation or SLS). OVRLAP then determines whether the $I_o$ interrogation signal is decoded depending on the dead time attendant to each interfering signal. Overlapping inteference signals are assumed to garble desired signals to the extent that they cannot be decoded regardless of the relative power differential. Other interference devices, such as false sidelobe suppressions and intermode garble, are also checked by the transponder model. The model then prints out the reply arrival times at $I_o$ generated by the signal environment for all replies that pass the downlink power cull. These times are based on the transmission time of the interrogation, the two-way propagation time, and the processing time at the transponder.

[a]The mainbeam dwell of aircraft for both the Long Beach ATCRBS interrogator and the LAX4 DABS sensor was 0.051 seconds.

## Downlink Power Cull

The calculation of nonsynchronous reply arrival times is accomplished in subroutines FRUIT and SLFRT, with FRUIT determining $I_O$ mainbeam arrival times and signal strengths and SLFRT performing the same operations for the $I_O$ sidelobes and backlobe. The model calculates the arrival time and signal strength of fruit replies to the $I_O$. Those replies that are received above the sensors MTL (typically -86 dBm) are retained for the processor routines.

## DABS Processor

Several target evaluators are built into the model to accommodate variations in the types of FAA processors. The basic routine is subroutine PROCES, which simulates the processing of DABS all-call and roll-call replies. PROCES receives arrival times of each type of reply, both synchronous and nonsynchronous fruit, entering the processor. The fruit arrival times are compared for overlaps, and a determination is made as to whether the valid replies are decoded correctly (based on the location and length of the error, the type of overlapping reply, and the relative signal strengths).

## ATCRBS Processor

The simulation of the ATCRBS processor, subroutine ATEVAL, maintains hit and miss counts for each in-process target, and correlates replies whose time-of-arrival places them in the range bin appropriate to the type of processor used with the $I_O$. The times-of-arrival are also used to determine reply overlaps. Garble flags are maintained for each target in the course of simulating code validation processes.

## ATCRBS MODE OF DABS PROCESSOR

The primary differences between target detection for the ATCRBS processor associated with the DABS sensor and the traditional ATCRBS processor are

azimuth determination via monopulse and target-to-track correlation. Because amplitude-monopulse azimuth determination can be accomplished with a single pulse, the number of desired target replies can be minimized. Improved target records can be obtained via the target-to-track update process.

Approximately six ATCRBS-Only interrogations will be transmitted during the mainbeam dwell time of a DABS sensor. These replies are correlated in range, azimuth, and high-confidence code bits to obtain target declaration and code estimates. Target parameters are updated on each scan based on the new target formations.

### Output

The model outputs are summarized in TABLE D-2. The outputs from the DABS and ATCRBS target processors are fed back to the beginning of the simulation cycle, subroutine ACTIVE. Another cycle is then initiated, based on the completion of roll-call transactions, the acquisition of new targets by all-call, and the transition of old targets out of the mainbeam of the $I_o$.

## TCAS SIMULATION ROUTINE

The performance predictions computed using the DABS/ATCRBS/AIMS PPM are based on environmental interrogator/transponder interactions tabulated during one complete scan (4.62 seconds for both LAX-4 and Long Beach) of the selected interrogator-of-interest ($I_o$). Each transponder's reply history is computed, in its entirety, based on its reply record to $I_o$ during the $I_o$ mainbeam dwell (0.051 seconds). During this interval of time, any terminal area transponder distribution could not shift in such a way that would result in a significant change in TCAS transmission rates.[a] A statistical TCAS submodel was therefore developed to provide the DABS/ATCRBS/AIMS PPM with arrival rates of TCAS and RBX signals at each transponder in the modeled environment. This is accomplished by establishing arrays that store the arrival rates of four types

[a]The maximum terminal area aircraft speed is about 300 nmi/hr.

TABLE D-2

DABS/ATCRBS/AIMS PPM OUTPUTS

Transponder Performance

- Probability of reply to the $I_o$ for each aircraft
- Target run lengths
- Reply histories
  - Reply arrival times
  - Location of missed relies in run length
  - Cause of missed replies
  - Identity of interferer

Interrogator-of-Interest Performance

- Fruit rate after each simulation cycle
  - ATCRBS
  - All call
  - Roll call
- Fruit reply times and garbles
- Valid reply times
- ATCRBS target detection summaries
  - Target declaration
  - Code validation indicator
  - Azimuth and range
  - Target start and end azimuths
- DABS transactions
  - Reply times
  - Garble conditions
  - Azimuth and range

of signals that may arrive at each transponder from the deployed TCAS and RBX. The four signal types are:

1. ATCRBS interrogations
2. ATCRBS suppressions
3. DABS interrogations with the address of the DABS target transponder
4. DABS interrogations with an address other than that of the DABS target transponder.

The antenna couplings used in the TCAS submodel are illustrated in Figure D-2. These patterns are derived from measured data for the Boeing 727 antenna/airframe configuration. Note that the DABS/ATCRBS/AIMS PPM uses a nominal transponder antenna gain of -2.5 dBi.

## Simulation of RBX/TCAS

The subroutine RBXRUN of the TCAS submodel simulates the DABS formatted signals that communicate between each TCAS-equipped aircraft and each RBX in the environment. One RBX unit is located at each terminal ATCRBS site. The RBX transmits squitters, using a DABS-formatted signal, once every 4 seconds. Each TCAS-equipped aircraft within 25 nmi of the RBX interrogates the RBX at an average rate of once every 4 seconds.[a] The path loss from each RBX and TCAS to each aircraft in the environment is calculated to determine the RBX/TCAS signal arrival rates. These arrival rates are then stored in the appropriate arrays.

## Simulation of TCAS/ATCRBS

TCAS-equipped aircraft use the 4-step sequence shown in Figure D-3 to interrogate ATCRBS-equipped aircraft. The peak power transmitted is 250 watts (referred to the antenna). The sequence begins with the top antenna. A

[a]Beyond 25 nmi, the TCAS interrogation rate to RBX units was computed as 0.25/(R x 6 - 144) per second, where R is the range in nmi. This results in a linear monotonic decrease in the interrogation rate as a function of range.

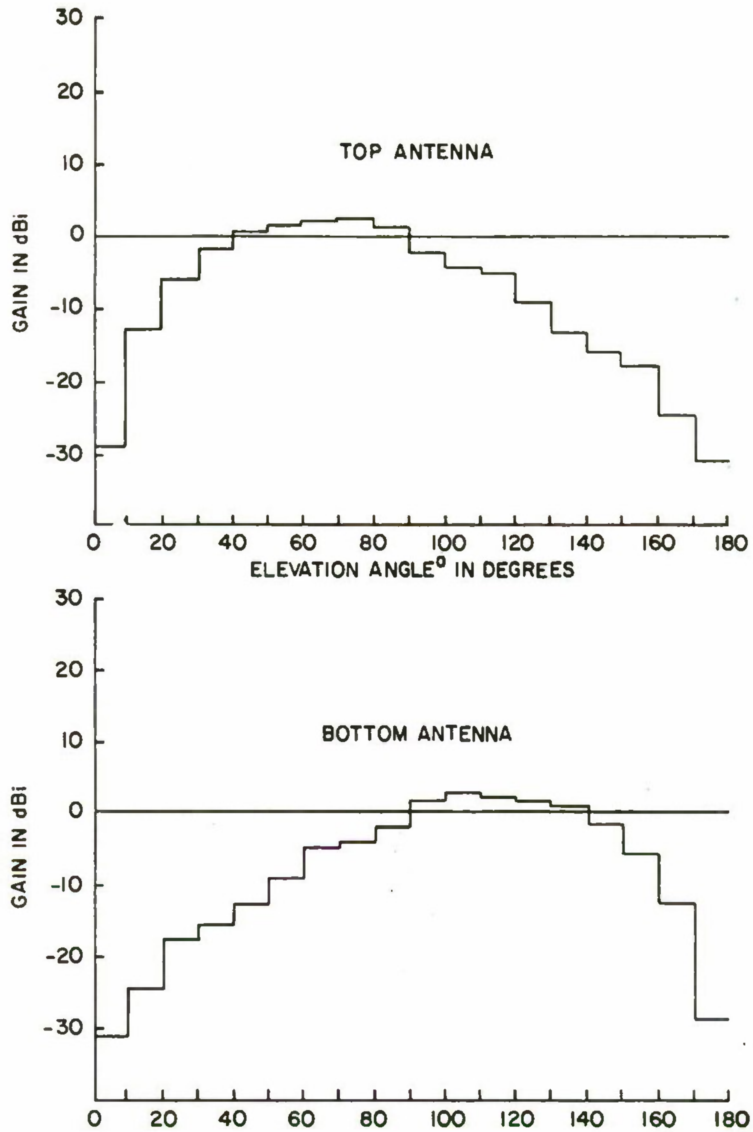


Figure D-2. Quantized vertical antenna patterns[b] assumed for TCAS and deployed aircraft.

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[a]Elevation angles: 0° - directly above aircraft, 180° - directly below aircraft.

[b]Antenna patterns derived from those of a 727 air frame.

NOTES: I DENOTES MODE C ATCRBS - ONLY
ALL-CALL INTERROGATION
S DENOTES SUPPRESSION PAIR

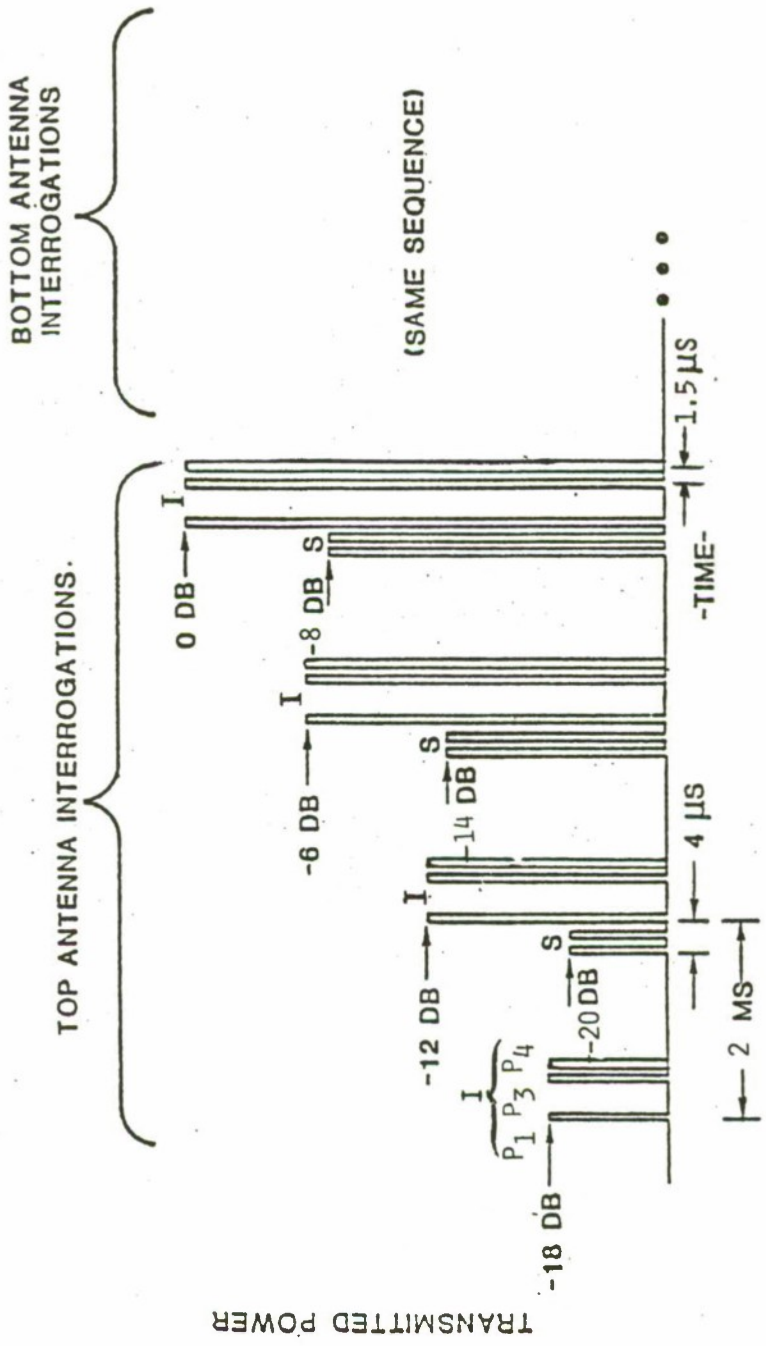


Figure D-3. TCAS/ATCRBS mode transmissions.

low-power interrogation (-18 dB) is followed by a suppression pulse pair (-20 dB) approximately 2 ms later, that precedes by 4 μs a second interrogation at -12 dB. This pattern is repeated in 6 dB steps until maximum interrogation power is reached. The entire 4-step sequence is then transmitted from the bottom antenna. The procedure is repeated once per second.

This technique of using increased power interrogations preceded by a suppression pulse pair is used to divide the surrounding ATCRBS aircraft population into smaller population subsets to facilitate efficient tracking by the TCAS computer system. This technique, referred to as "Whisper-Shout," is discussed in Reference 5.

The basic task in the simulation of the ATCRBS mode of TCAS is path-loss calculations required to determine which interrogations or suppressions of the sequence are received above transponder sensitivity by all aircraft in the environment. The appropriate suppression and interrogation arrival rate arrays are established accordingly.

Simulation of TCAS/DABS

TCAS tracks DABS-equipped aircraft both in altitude and range. Each DABS aircraft transmits a DABS-formatted reply at a minimum rate of once per second. Initially, the TCAS-equipped aircraft will discern the presence of a DABS aircraft by monitoring replies containing the DABS-equipped aircraft altitude and identity. The frequency of the TCAS-equipped aircraft subsequent surveillance transmissions to the DABS-equipped aircraft is dependent upon the relative range and altitude separations of the aircraft. The separation-distance/TCAS-surveillance rate parameters, and ECAC's modeling procedures, are discussed below.

Two DABS interrogation arrival rate arrays are maintained for each DABS-equipped aircraft. One contains arrival rates of DABS interrogations addressed to that particular aircraft, and the other contains arrival rates of DABS interrogations addressed to other DABS aircraft.

The TCAS routine uses the following step-by-step procedure to generate the DABS signal environment at each aircraft due to each TCAS in the environment:

1. Compute the power levels of DABS replies received by the TCAS from all other DABS-equipped aircraft and eliminate from consideration those aircraft whose replies are received below the TCAS-equipped aircraft MTL.

2. Compute the horizontal and vertical boundaries of the TCAS track volume and determine if the subject DABS aircraft is contained in this volume. The vertical boundary is fixed at ±5000 feet. The horizontal boundary varies with the TCAS-equipped aircraft interference-limiting state which is a function of the local TCAS- and DABS-equipped aircraft distribution. If the TCAS-equipped aircraft is operating at full-power, the horizontal boundary extends to 12.66 nmi. If the TCAS-equipped aircraft's power is reduced to 125 watts or to 31.25 watts due to interference-limiting, the horizontal boundary is reduced to 7.66 nmi. If the TCAS-equipped aircraft has reduced power by 12 dB and still cannot satisfy the interference-limiting inequality, then the horizontal track boundary collapses to zero and TCAS transmissions cease. If the aircraft is within the track volume, then it is assumed the aircraft is in the roll-call state. The rate of interrogation is computed to be the number of interrogations made over the 10-second roll-call sequence, divided by 10. The entries in the sequence shown in TABLE D-3 are the maximum number of interrogations allowed to produce one valid reply during each 1-second scan of the 10-second roll-call sequence.

The results of a Lincoln Laboratory computer analysis[12] giving the probability of successfully decoding a DABS reply as a function of both the

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[12] McDonald, T. S., BCAS DABS Reply Processing Performance Analysis, Report No. 42W-5062, Massachusetts Institute of Technology, Lincoln Laboratory, Lexington, MA, 8 October 1976.

fruit level which is related to the local aircraft density (within 30 nmi) and received power level[a] was used in the procedure described above (and in the following steps). The results of that analysis, as presented in Reference 2, are shown in Figure D-4. As an example, consider an aircraft at a range

TABLE D-3

ROLL CALL SCAN/INTERROGATION CONSTRAINTS

| Scan | Maximum Number Of Interrogations |
|---|---|
| 1 | 5 |
| 2 | 4 |
| 3 | 3 |
| 4 | 2 |
| 5 | 2 |
| 6 | 2 |
| 7 | 2 |
| 8 | 2 |
| 9 | 2 |
| 10 | 2 |

of 5 nmi and assume that its replies to TCAS transmissions are received at -60 dBm. Furthermore, assume that the local aircraft density is 0.12 aircraft per square nmi. Then the probability of correctly receiving a reply is, from Equation D-1, $P_{12} = P_o\ (-60.0) \times P_{06}\ (-60 - 10(\log 2)) \approx 0.77$.

At this point, the model computes the required interrogation rate to this transponder to elicit 1 reply per second. This is accomplished using Monte Carlo techniques in conjunction with the probability of decode, and the scan/interrogation table.

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[a]Each aircraft was assumed to transmit 150 fruit replies per second. Fruit replies from aircraft at ranges of up to about 30 nmi are received at a TCAS above MTL, and are the signals that predominate in garbling elicited replies to the extent that they cannot be decoded. This rate was selected based on the average ATCRBS interrogation rate (about 200/s) computed using the DABS/ATCRBS/AIMS PPM.

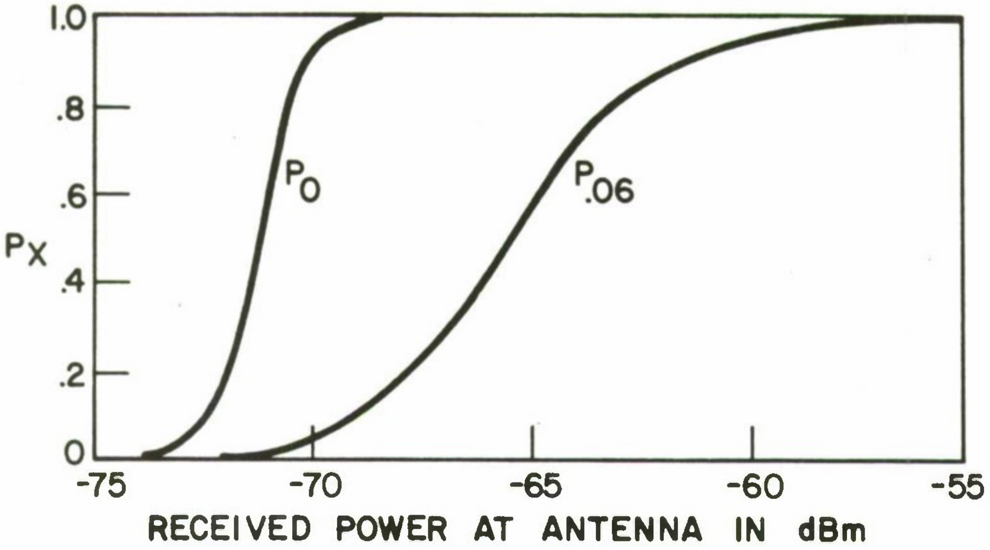


Figure D-4. Assumed probability for correctly receiving a reply ($P_x$) as a function of received power for aircraft densities of 0 ($P_0$) and 0.06 ($P_{06}$) aircraft/sq. nmi.[a]

$$P_x = P_0 \; (P) \times P_{06} \; (P - 10 \; (\log \frac{x}{.06} )) \qquad \text{(D-1)}$$

where

$P_x$ = probability of reply detection

$P$ = received power at antenna (dBm)

$P_0$ = probability of detection at 0 density

$P_{06}$ = probability of detection at .06 density

$x$ = aircraft density (aircraft/sq. nmi)

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[a]Note that the $P_{06}$ curve is shifted to the right by 3 dB from the Reference 2 curve to reflect the deletion of error-correction coding from the TCAS/DABS reply data field.

3. If the DABS aircraft is within the vertical boundary but outside the horizontal boundary of the track volume, calculate the "Time of Earliest Encounter," TE, (TE = range/maximum closure rate). The closure rate is defined to be 600 nmi/hr for all terminal area encounters. If TE is less than 76 seconds (TE <76 corresponds to a range separation of less than 12.66 nmi), the aircraft is assumed to be roll-called as described above.[a] If TE is greater than 76 seconds, the aircraft will be either interrogated for acquistion and/or placed in dormancy for a period of TE-70 seconds (TE-40 if limited). The acquisition/dormancy interrogation sequence is described below in step 4.

4. The rate at which TCAS will interrogate aircraft through acquisition interrogation is computed as follows. There are 4 acquisition trials consisting of six 1-second scans. The maximum interrogator failures for a given trial/scan are shown in TABLE D-4.

TABLE D-4

ACQUISITION SCAN/TRIAL INTERROGATION CONSTRAINTS

| SCAN | ACQUISITION TRIAL | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1 | 3 | 2 | 1 | 1 |
| 2 | 3 | 2 | 1 | 0 |
| 3 | 3 | 2 | 1 | 0 |
| 4 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 |

[a]If the TCAS-equipped aircraft is in an interference-limiting state, replace 76 with 46.

The model uses 1) the test data mentioned above (Reference 13) and the received aircraft signal level to compute the probability of decode, and 2) the acquisition trial/scan table to compute the resultant acquisition interrogation rate.

Initially the model computes the length of time (TS) required for a TCAS-equipped aircraft to receive two correlating decodable replies separated by less than 41 seconds.[a] If after three iterations of this procedure, two correlating replies from an aircraft have not been decoded, the acquisition interrogation rate to that aircraft is assumed to be zero. For aircraft whose replies are correlated, the following procedure is used. Acquisition interrogations are transmitted in accordance with the acquisition trial/scan table. For example, in the first scan of the first trial as many as four interrogations may be transmitted, one successful and three unsuccessful. If two successful interrogations are made in any given scan, or one successful interrogation is made during any given 6-scan trial,[b] acquisition terminates and the aircraft is placed in dormancy for a period $T_D$ of TE-70 (TE-40 if limited) seconds. If no decodable replies are elicited during any given 6-scan trial, the TCAS-equipped aircraft waits for a period, TH, up to 40 seconds to detect a squitter reply or a reply elicited by another TCAS interrogator from that aircraft. If no decodable replies are received, then two correlating replies separated by less than 41 seconds are required to begin a new acquisition sequence. If a decodable reply is received, the trial counter is incremented and the following 6-scan trial/failure entries are used.

The three cases discussed below summarize the averaging techniques used to compute the appropriate acquisition interrogation rates for: 1) aircraft

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[a] A target is purged from surveillance processing if a second correlating reply is not received within 40 seconds of the first reply. These replies may be either replies elicited by another TCAS-equipped aircraft or unelicited replies (squitter).

[b] A 6-scan interrogating sequence is terminated only if two replies are received during a single scan.

that are acquired and placed in dormancy; 2) aircraft purged from acquisition between trials; and 3) aircraft that are not acquired and not purged.

The acquisition interrogations rate, $R_A$, to aircraft beyond the track volume were computed as follows:

CASE 1 For aircraft acquired and placed in dormancy

$$R_A = I_A/(N_S + T_D + \sum_{i=1}^{n} T_{Hi})$$

where

$R_A$ = acquisition interrogation rate (per second)

$I_A$ = number of acquisition interrogations

$N_S$ = number of elapsed interrogation scans (1 scan is 1 second)

$T_D$ = dormancy time (seconds)

$T_{Hi}$ = time (seconds) between each trial until squitter reply (or reply elicited by other TCAS) is received, where n denotes number of elapsed trials. Note that the sum goes to n whereas between n trials there are only (n-1) squitter waiting periods. The extra waiting period corresponds to the waiting time following dormancy necessary to detect another squitter reply and thus trigger repetition of the procedure.

CASE 2 For aircraft that are not acquired and the 4-trial sequence is terminated with less than 4 trials due to failure to detect a squitter reply between any given trial.

$$R_A = I_A/(N_S + \sum_{i=1}^{n} T_{Hi} + Ts)$$

Ts = length of time (seconds) required for a TCAS-equipped aircraft to receive two correlating decodable replies separated by less than 41 seconds. This time is included,

since the aircraft is purged from surveillance processing if, after 40 seconds, a squitter reply is not decoded. Two correlating replies separated by less than 41 seconds are then required to repeat the procedure. All other terms are defined under CASE 1 above.

CASE 3 For aircraft that are not acquired and the 4-trial sequence is completed without receipt of an elicited reply.

$$R_A = 19/(N_s + \sum_{i=1}^{4} T_{Hi})$$

19 = maximum number of interrogations during the 4-trial/6-scan sequence. All other quantities are defined under Case 1 above. Following $T_{H4}$ the trial counter is set equal to 1 and the trial/scan sequence is repeated.

Interference-Limiting

The TCAS model will initally assume a peak TCAS output power of 250 watts at the antenna. The number of DABS interrogations and ATCRBS interrogations made by a TCAS-equipped aircraft are counted as well as the number of TCAS-equipped aircraft within squitter range.[a] Substituting these computed quantities into the TCAS interference-limiting equation, Equation 1, the TCAS submodel determines if power should be reduced. If so, power and sensitivity are reduced by 6 dB and the entire procedure is repeated. If the inequality is not satisfied after two 6 dB reductions, then collision-avoidance activity for that particular TCAS-equipped aircraft is terminated.[b]

It should be noted that the TCAS submodel is cycled twice for each

[a]TCAS-equipped aircraft within squitter range refers to those aircraft whose replies are received at a power level such that a reply may be decoded at least once every 40 seconds.

[b]According to design, the inequality is tested on a second-by-second basis.

simulation. This is necessary to generate accurate acquisition interrogation rates. As mentioned above, replies are monitored by TCAS-equipped aircraft and serve to initiate and continue the acquisition procedure. These replies include not only the 1/s minimum squitter reply rate but also those replies elicited by other TCAS-equipped aircraft. Therefore, the first simulation cycle is designed strictly to determine the average reply rate of each DABS-equipped transponder in the selected environment.

## Model/Submodel Interface

The computed steady-state TCAS signal environment is then merged with the DABS/ATCRBS/AIMS PPM by randomly scheduling (uniform distribution) transmission times. A flow diagram of the TCAS simulation routine is shown in Figure D-5.

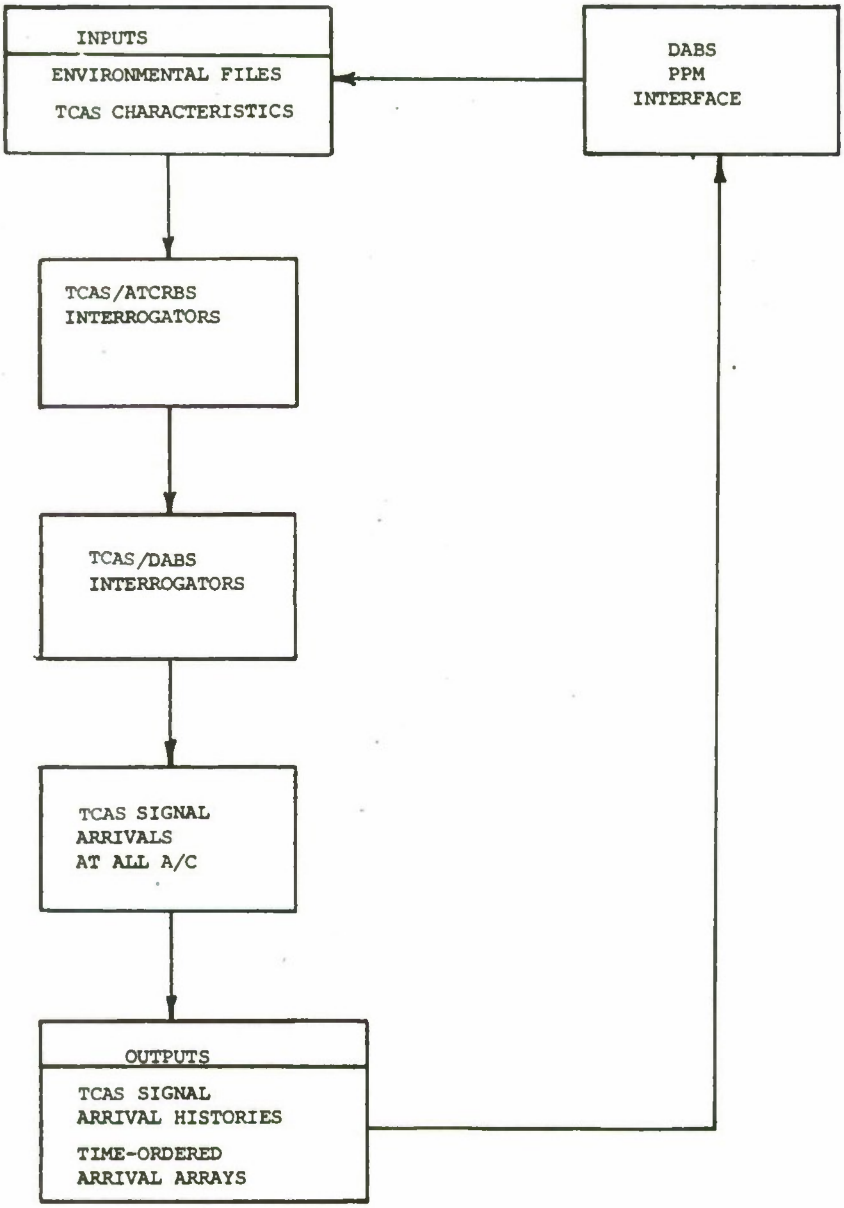


Figure D-5. TCAS flow diagram.

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